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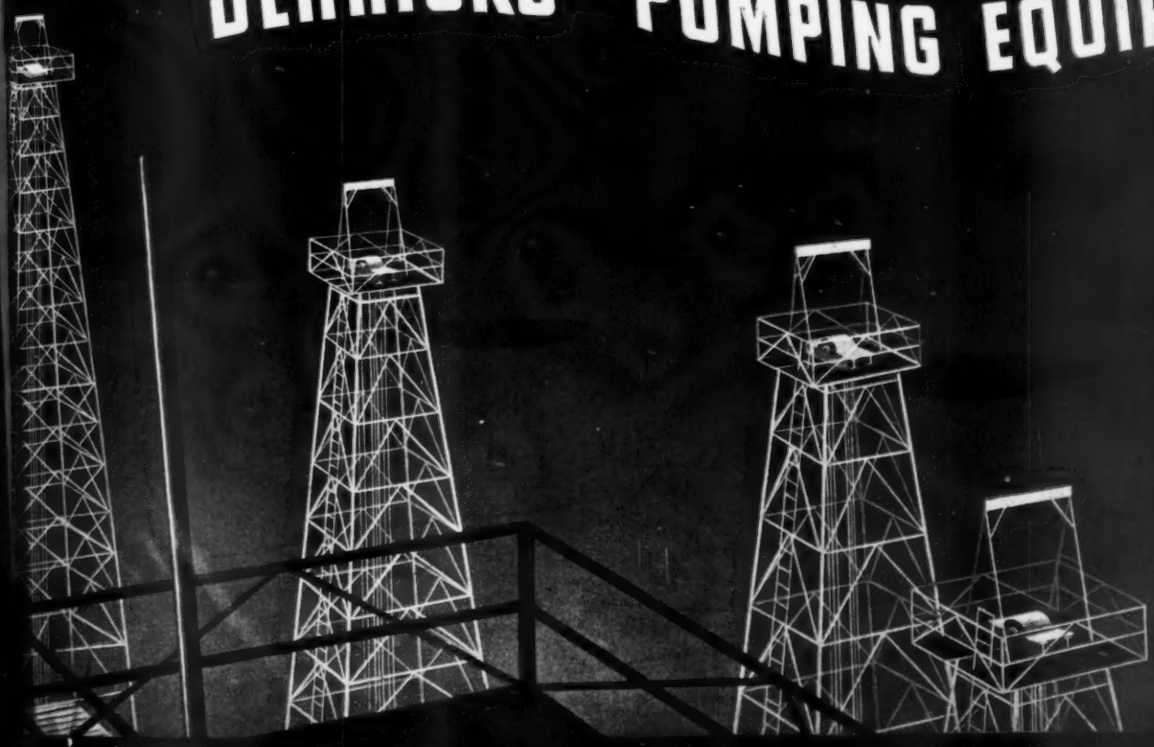

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THE Petroleum Engineer

OCTOBER 1937

VOLUME IX NUMBER 1

A MAGAZINE OF METHODS FOR OPERATING MEN

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Meetings

- American Welding Society, 18th Annual Meeting and Welding Exposition—October 18, 19, 20, 21, and 22, Atlantic City, New Jersey.
- American Institute of Mining and Metallurgical Engineers—October 18, 19, 20, 21, 22, and 23, Atlantic City, New Jersey.
- Mid-Continent Oil and Gas Association of Texas, Annual Convention—October 29 and 30, Dallas, Texas.
- California Natural Gasoline Association—November 4, Richfield Building, Los Angeles, California.
- American Association of Petroleum Geologists, Pacific Section—November 4 and 5, Los Angeles, California.
- American Petroleum Institute, 18th Annual Meeting—November 9, 10, 11, and 12, Stevens Hotel, Chicago, Illinois.
- American Institute of Chemical Engineers, Annual Meeting—November 17, 18, and 19, St. Louis, Missouri.
- American Society of Mechanical Engineers—December 6, 7, 8, 9, and 10, New York, N. Y.
- International Petroleum Exposition—May 14, 15, 16, 17, 18, 19, 20, and 21, 1938, Tulsa, Oklahoma.

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The Course of Oil

By K. C. SCLATER

Experiment Station Dedication

Dedication this month of the new administration and laboratory building at the Petroleum Experiment Station of the U. S. Bureau of Mines at Bartlesville, Oklahoma, brings into retrospect an unassuming phase of U. S. government activity, which in the field of petroleum technology has accomplished results that have become a tradition of pioneering and achievement.

Since it was founded in 1917, there has emanated from this Station a wealth of technical information in the form of several hundred special reports dealing with all branches of the petroleum and natural gas industries. The laboratory and field work, of which these reports are the results, have laid the foundation for sound principles of practice in the petroleum industry throughout the world. Wherever petroleum or natural gas are produced, transported, or refined, there will be found applications of processes the inception of which are the fruitful outcome of studies first undertaken by technologists at the Bartlesville Station. Having no interests to serve other than that of advancing technology to the end that waste in the production and handling of petroleum and natural gas will be reduced, safety and efficiency in operations promoted, and economic development furthered, the Station has acquired an enviable standard of integrity and authority in the industry as a clearing house for the solution of involved technical problems.

Enlargement of the Station's facilities is an auspicious event. It can be confidently accepted as a promise of greater substantial aid to the industry in grappling with an ever-increasing maze of difficult technical problems the solution of which is bound up with the industry's general welfare.

Effective Remedy Proposed

A solution to the problem of retarding the rapid decline of reservoir pressure in the East Texas field seems in sight. It appears to have some merit. For some weeks the Railroad Commission has had a corps of engineers in the field checking wells individually to find out how many "dead" ones there really are. Many have been the charges, true it now appears, that there are more "dead" wells than reported on field records. News of the Commission's action to investigate for itself these charges of "dead" wells was the signal for certain operators to embark suddenly on a clean-out and swabbing program on their wells. This sudden burst of activity in many instances was construed as a frantic effort to revive wells that long were "dead." Whatever the outcome, the Commission's action has had a salutary effect.

Now comes the information that already as a result of the survey, which at this writing is still in progress, the Commission will probably revise the method of allocating allowables of all wells in the East Texas field. Those wells that cannot produce at least twenty barrels of oil daily, the marginal well allowance, will have their daily allowable set at what they actually can produce, even though only a barrel a day. Thus it is hoped to end the unscrupulous practice of claiming allowables for "dead" wells, and making up such illegal allowables from the more productive wells on a lease.

An incidental result of this survey is an order of the Commission requiring a check valve in the flow line of each well that produces with another or other wells into a common flow line or tank. This requirement was necessary in order that the "dead" or nonproducing wells could be the more readily detected.

Should the revised method of allocating well allowables be put into effect, it may affect—and profoundly—the drilling program in the field.

An effective and continued enforcement of the regulations for allocating well allowables as proposed must depend on a periodic test of each well. With a total of almost 24,000 wells in the field, this is no small task.

It cannot be denied that far-reaching advantages may acrue to the field should the proposed method be adopted. The field allowable would be automatically reduced and the rapid decline in reservoir pressure retarded; probably as important, also, is the fact that it would discourage dense drilling. Either one of these advantages alone justifies the proposed revision of allocating allowables—a revision that should have been made long ago.

Reduce Self-Imposed Tax

State control of drilling to conserve potential oil production was urged before the Mineral Law Section at the annual convention of the American Bar Association. It was charged that between 4000 and 5000 unnecessary wells costing between 80 and 100 million dollars are drilled annually. This enormous expenditure is tantamount to a self-imposed production tax that is equivalent to about ten cents per barrel of oil produced. Not only is this viewed as a useless cash outlay, the unnecessary wells also waste reservoir energy, the ultimate result of which is an increase in ultimate lifting cost.

With threats of further taxation of the oil industry in the air, these are serious charges. They put the industry in a predicament and place a formidable obstacle in its path in any fight for reduced taxation.

Curtailment of unnecessary drilling in proved fields may well demand the concerted action of the oil-producing States. It falls in the same category as proration and well-spacing, and should be fostered by the States. In this connection, it has been suggested that "the movement toward drilling control should be led by the States themselves acting through the Interstate Compact Commission."

The staggering total of the industry's self-imposed expenditure for drilling unnecessary wells, and their baneful results, are ample evidence of the urgent need of closer controlled drilling.

« « HIGHLIGHTS IN OILDOM » »

FORMAL OPENING OF THE OIL-WORLD EXPOSITION AT HOUSTON

Antitrust Trial Gets Under Way at Madison

Twenty-four oil companies, 47 individuals, and three publishing companies went on trial October 4th at Madison, Wisconsin, in the federal government's antitrust oil case. The defendants are charged with conspiracy to fix and raise gasoline prices in the Mid-Continent, constituting a combination in restraint of trade.

Unofficially it has been disclosed that the defendants will contend that any action on their part to maintain prices was a continuation of stabilization activities under the oil code of the National Recovery Act. Buying pools were sponsored under the code; buying pools are charged in the indictment as a part of the conspiracy, it is pointed out.

The defendants' position, as evidenced in statements during preliminary court skirmishes, was that the indictment charges them with doing what they were requested or required to do under the NRA.

A statement of one of the defendants said:

"The government's charge turns on whether a practice legally started and carried on under the recent NRA oil code was continued in illegal manner after the codes were killed by the Supreme Court. There seems to be some question as to when the oil administrator (Secretary of Interior Ickes) and the Department of Justice withdrew their approval."

Failure of jobbers to obtain gasoline at prices that prevailed in 1933 and 1934 "led them to claim that the direct cause of their failure to buy at prices which had been made possible by hot oil and refineries operating at a loss in order to protect capital investments, was purchasing done by major companies," a source close to the defense declared. Protests of jobbers led to a grand jury investigation that resulted in the present indictments.

The oil companies are charged by the government with signing jobbers to long-term contracts, basing prices on the spot market in the field, and then by paying excessive prices to small refiners forcing up the market and so causing the entire price structure in ten middle-western states to rise.

●

Fitts Proration Remains on Well Basis

Operators in the Fitts Pool, Oklahoma, have been notified by W. J. Armstrong, chief conservation officer, that in view of their lack of agreement on plans for the operation of the field on a lease basis continued operation on a well basis will be necessary. He explained that the state corporation commission felt that the application for lease basis operation should not be granted as there was a feeling of uncertainty among operators. The commission will continue to enforce proration on a well basis until operators decide what recommendations they desire to make to the commission, he stated.

●

May Propose Tax on Oil Leases

Representative Clarence Farmer of Fort Worth, Texas, has announced he is considering introducing a bill in the state legislature to tax mineral leases, claiming that major oil companies are obtaining a virtual monopoly of the Texas lands that may contain oil. The bill, as tentatively outlined, would levy a tax in addition to the usual ad valorem tax, and it would be based on the value of the land for mineral purposes. If the lessee of the land valued it at $1.00 an acre for oil purposes he would place a percentage tax of, say, ten percent on it.

●

Operating Rules Issued for Texas Fields

The Texas Railroad Commission has issued orders prescribing operating rules for the Avoca field in Jones County, the South Burnell field in Bee County, and the South Calliham (Claunch area) field in McMullen County.

(*Continued on page 14*)

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Ten-acre spacing is prescribed for the Avoca and South Burnell fields, and a five-acre plan for the Claunch area of the South Calliham field. Allowables for the Avoca field will be based 50 percent on acreage and 50 percent per well. A gas-oil ratio of 2000 cu. ft. of gas per bbl. of oil also was ordered.

Rules applied in the Claunch area, in which conditions are not comparable to those of the high-pressure districts in the South Calliham field, will not abrogate regulations established for the main area, engineers said. The commission found there were two reservoirs in the field that should be governed by separate rules.

●

Southern California Section A.I.M.E. Meets in Los Angeles

The one-day meeting of the Petroleum Division of the Southern California Section of the American Institute of Mining and Metallurgical Engineers, held in Los Angeles October 1st, was featured by a symposium on developments in the newer fields of California, and the reading of papers on technical subjects pertaining to research projects, as well as the application of equipment with a view of obtaining greater efficiency in drilling and production practices. In the evening an informal dinner was held at the University Club.

R. P. McLaughlin, associate chairman of the Petroleum Division of the Southern California Section of the A.I.M.E., was in charge of arrangements for the meeting. He was ably assisted by E. K. Parks, Standard Oil Company of California, chairman of the program committee and chairman of the morning session; W. H. Geis, consulting engineer, chairman of the entertainment committee, and chairman of the afternoon session; and G. A. Joslin, secretary of the local section. John Herman, chairman of the Southern California Section, opened the dinner meeting, which was presided over by R. P. McLaughlin.

R. C. Allen, president, and A. B. Parsons, secretary, were present from the national headquarters of the A.I.M.E.

●

Sales of Oil Equipment to Canada Increase

During the first six months of 1937 Canada purchased from the United States petroleum equipment valued at $667,159, as compared with $72,059 worth for the first half of 1936, reports the Canadian Department of Commerce. Purchases of refining and processing equipment amounted to $193,865 for the first six months of 1937, as compared with $73,746 for the same period of last year.

●

Predict General Use of Diesels in Automobiles

The general use of Diesel engines in automobiles is but three or four years away, is the belief of C. F. Cummins, president of the Cummins Engine Company, Columbus, Indiana. At the national convention of the Society of Automotive Engineers in Tulsa, Oklahoma, Cummins told many interesting facts concerning the developments his company has made with Diesels for automotive use.

Recent tests show that a heavy late model automobile equipped with a Diesel engine can be driven from Los Angeles, California, to New York at a fuel cost of $7.63 at speeds up to 90 miles per hour, Cummins said. A heavy truck, fully loaded, can be driven over the same route in 96 hours at a fuel cost of $12.50, and a bus has made a similar run in 72 hours at a cost of $22.00 at speeds from 60 to 70 miles per hour, he further stated.

The use of Diesel engines in automobiles has been retarded, Cummins said, due to the fact that users now demand engines of 200 hp. instead of one of 120 hp. as formerly. This demand for the higher rated Diesel came just as the smaller engine was being perfected. Now the automotive Diesel has been developed to 150 hp., and Cummins says it will be but a relatively short time until the 200-hp. mark is reached.

The Diesel engine's present and future place in the automotive industry was further discussed at the convention by Arch F. Campbell, manager of the Tulsa branch of the Waukesha Motor Company, who read a paper entitled, "Economic Place of Automotive Engines."

He explained the principles and recent developments made in the Hesselman Diesel, a low-compression engine that burns Diesel fuels, and in which the injection of the fuel is similar to the Diesel method, but which accomplishes ignition by means of a spark plug instead of by the heat of compression.

●

Mid-Continent Meeting A.I.M.E. at Oklahoma City

The well-attended fall meeting of the Mid-Continent Section of the American Institute of Mining and Metallurgical Engineers, held at Oklahoma City, Oklahoma, October 7, 8, and 9, was replete with interesting business sessions and enjoyable entertainment features. Papers read dealt with timely drilling and production subjects and were highly instructive.

●

Oil From Coal Studied in Scotland

Continued and even extended government aid would be necessary to produce oil from coal in Scotland at a price that would enable it to compete with imported oil, is the conclusion reached in the third annual report of the committee appointed by the Scottish Development Council, which, since January, 1934, has been investigating the practicability of obtaining oil from coal.

The report incorporated the findings of an investigation undertaken by a coalmasters' sub-committee to determine whether the smokeless fuel resulting from low temperature carbonization could be marketed at a figure that would make the production of oil by that process economical. It was found that such smokeless fuel could not be produced at an economical figure under present-day conditions. The report adds, however, that "there are available in Scotland classes of coal of suitable quality for any of the known processes for complete conversion to oil," with no solid fuel as a by-product.

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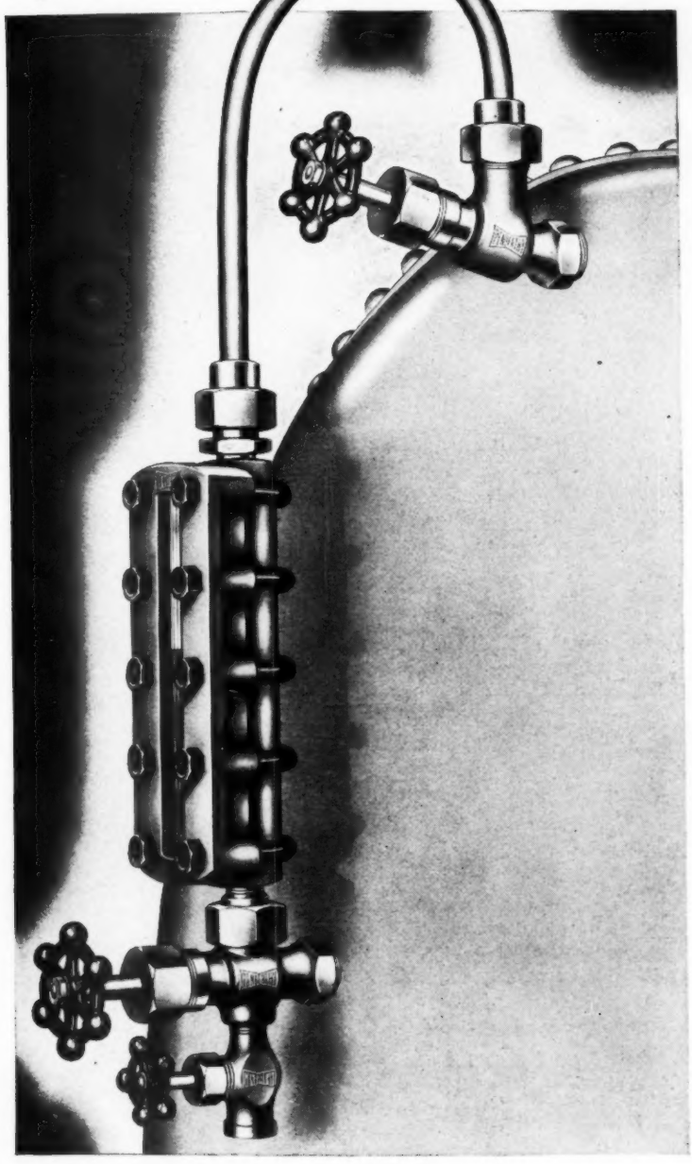

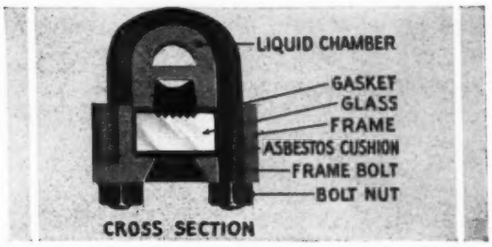

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Latest Activities In The Oil Fields

A NEW Hockleyensis sand field has been found in Bee County, Texas, near Normanna, by J. R. Dougherty with his No. 3 R. T. Hicks Estate. At a depth of 3657-70 ft. an eight-minute drill-stem test was made and 100 ft. of oil and 80 ft. of mud cut with oil were recovered through ¼-in. and ⅜-in. chokes.

●

The test being drilled by the Mexican government approximately eight miles west of Laredo, Texas, and Neuvo Laredo, Mexico, is being watched with interest by operators in the area. Already the test has struck a sand showing gas production. This sand, at a depth of 681-96 ft., was passed up after a drill-stem test was made and drilling continued. The test is known as the Administracion de Petroleo Nacional No. 1 Pet-Mex.

●

A new oil discovery in northern Barton County, Kansas, has been made by the Shell Petroleum Corporation at its No. A-1 Peterman, a wildcat in the SE NE SE of 13-16-14w. Operators reported the hole filled with 2650 ft. of oil in seven and one-half hours after plugs had been drilled at the top of the Arbuckle lime at a depth of 3340 feet. Production is from Dolomite formation at a depth of 3341-66 feet. Nearest production is the South Trapp pool, two and one-fourth miles to the northeast.

●

Attention is being directed to Music Mountain, nine miles south of Bradford, Pennsylvania, in the Bradford-Allegany area, where the Minard Run Oil Company is drilling an offset to the gusher brought in a few weeks ago by the Niagara Oil Corporation, the first for Pennsylvania in many years. Early in the month the Minard Run Oil Company's test was nearing the 1400-ft. level. As the Minard well is 200 ft. lower structurally it is thought that production may be found at a depth of less than 1600 ft., the depth at which the gusher was brought in.

The Ohio Oil Company has brought in its No. 1 Wyoming Oil and Gas Company, in the Bunker Hill structure, Carbon County, southern Wyoming, producing 5,000,000 cu. ft. of gas daily. The well is in wildcat territory, and is producing from the Shannon sands, logged at 1220 to 1488 feet.

●

Producing 43 bbl. of oil when agitated with a swab the Boston Oil and Gas Company's No. 1 Fox in Isabella County, Michigan, is causing it to be looked upon as a commercial producer. Production of this wildcat well, midway between the Sherman and Denver oil fields, is from the Monroe limestone.

●

Northwest Long Beach, California, may prove to be a new field. When the Hilldon Oil Company completed a wildcat in the area recently it was thought the area might be an extension to the Long Beach or Wilmington fields. Operators now are beginning to believe that such is not the case since the Hilldon Oil Company's No. 2 test flowed 750 bbl. of 24.3-gravity oil from a depth of 4135 ft. after being swabbed.

●

Three new pools have been discovered on the Gulf Coast of Louisiana within recent weeks. The Humble Oil and Gas Company's No. 1 Federal Land Bank opened a new area on the Crowley prospect. The well produced 679 bbl. of 36-gravity oil on the initial 24-hour test. The same company was responsible for opening a new pool at Potash, Plaquemines Parish, with its No. 11 Orleans Levee Board. The Continental Oil Company with its No. 1 Tate has discovered a pool in the Villa Platte area of Evangeline Parish, the well producing 125 bbl. of 47.6-gravity oil in 14 hours through 3/16-in. choke.

AVERAGE CRUDE PRICES

California	
Kettleman Hills	$1.19-1.43
Playa Del Rey	.80-1.16
Coalinga	.70- .90
Signal Hill	.80-1.21
Montana	1.35
Wyoming	.97-1.30
Colorado	1.12-1.18
New Mexico	.78-1.08
Texas	
North Central	.96-1.20
Panhandle	.91-1.08
West Texas	.78-1.08
Gulf Coast	.95-1.41
Darst Creek	1.09
East Texas	1.35
Talco	.73
Kansas	.98-1.30
Oklahoma	.98-1.30
Arkansas	.90
Louisiana	
Rodessa	$ .91-1.25
Gulf Coast	.84-1.41
North Louisiana	.90-1.22
Illinois	1.35
Kentucky	1.40
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.27
Pennsylvania	
Bradford	2.60
Southwest	2.30
Eureka	2.25
Buckeye	2.10
Corning	1.27
West Virginia	1.67
Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in Barrels)

	B. of M. Dept. of Int. Calculations (Sept.)	Week Ended Oct. 2, 1937	Week Ended Sept. 4, 1937	Week Ended Oct. 3, 1936
Oklahoma	633,600	581,200	639,500	547,500
Kansas	200,900	184,500	192,550	157,800
Panhandle Texas		79,950	80,150	61,300
North Texas		73,750	74,850	61,100
West Central Texas		33,750	33,800	27,400
West Texas		220,850	232,850	172,350
East Central Texas		116,550	127,450	70,800
East Texas		479,200	474,450	436,550
Southwest Texas		272,950	264,700	*166,500
Coastal Texas		217,000	221,750	176,100
TOTAL TEXAS	1,413,600	1,494,000	1,510,000	1,172,100
North Louisiana		89,650	88,950	78,000
Coastal Louisiana		174,650	176,150	157,700
TOTAL LA.	247,900	264,300	265,100	235,700
Arkansas	29,900	38,700	36,300	28,200
Eastern	124,300	144,750	140,800	114,550
Michigan	40,400	54,600	48,550	29,750
Wyoming	55,900	57,700	54,200	41,250
Montana	18,200	18,200	17,850	15,750
Colorado	5,000	4,650	4,800	4,900
New Mexico	101,400	114,650	114,200	79,100
TOTAL EAST OF CALIF.	2,871,100	2,957,250	3,023,850	2,426,600
California	638,200	690,200	668,700	564,100
TOTAL U. S.	3,509,300	3,647,450	3,692,550	2,990,700

*Revised.

PUMPING SLUSH IS "DUCK SOUP" FOR "CATERPILLAR" DIESELS

MUD-PUMPING is the hardest power-task in oil-drilling. Pressure must be maintained. But "Caterpillar" Diesel Engines can "take it." They're built for it — with an extra margin of dependability and endurance for extra-tough going. On this Pure Oil Company operation, near Cisne, Illinois, two D13000 Diesels (125 hp. each), working in 2-hour relays, did an unbeatable pumping-job. In conjunction with another Diesel running the rotary table, the total 24-hour consumption of 6c Diesel fuel was about 220 gallons — costing $13.20 a day.

Over the same period, a steam-powered rotary rig 1000 feet away used 100 barrels of crude oil, at $1.26 a bbl. — costing $126 a day. The difference, in favor of the Diesels — $112.80.

Not only is Diesel power, as perfected by "Caterpillar," outstandingly cheaper than all other types available for oil-drilling . . . it is also easy to move; involves no water-supply problem; and its dependability is backed up by a widespread service-organization whose facilities are available 24 hours a day.

Any dealer can show you scores of money-saving records made with "Caterpillar" Diesel Engines in oil-field applications. Or, write us direct for evidence-in-print.

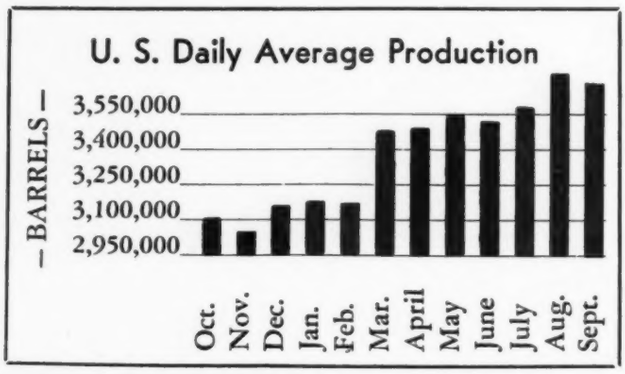
SEVEN ENGINE SIZES — 44 TO 160 HP.

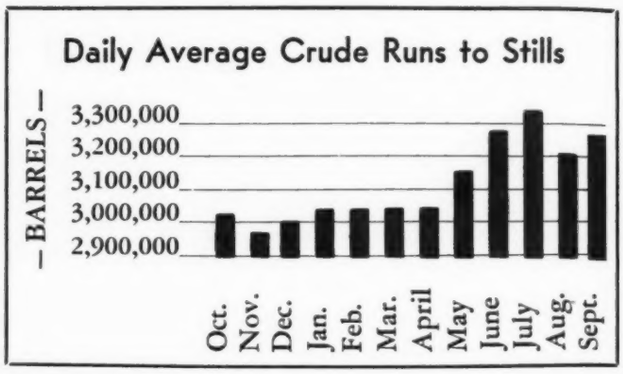
CATERPILLAR DIESEL ENGINES

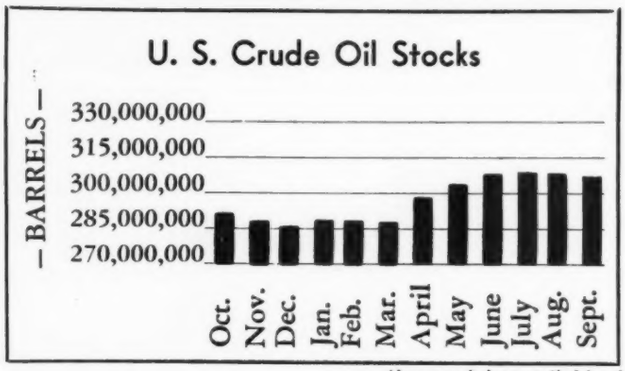
REG. U.S. PAT. OFF.

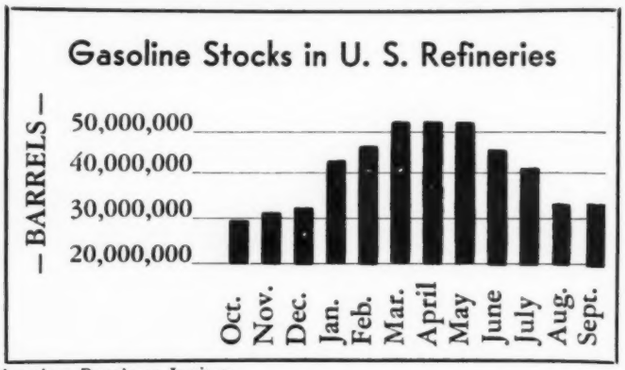
CATERPILLAR TRACTOR CO., PEORIA, ILL. . . . WORLD'S LARGEST MANUFACTURER OF DIESEL ENGINES

Summary of Petroleum Statistics and Field Activities









Above statistics supplied by the American Petroleum Institute.

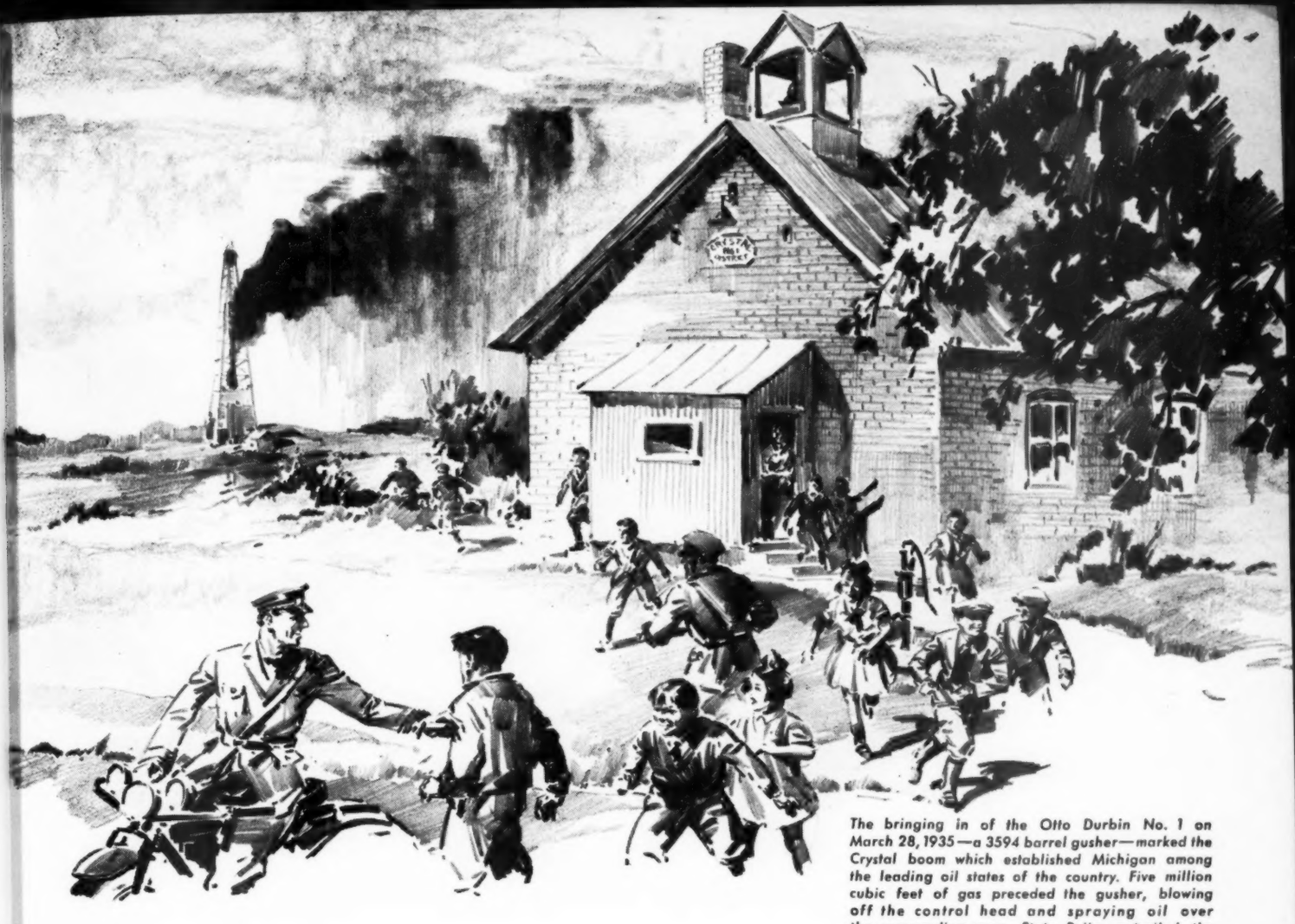
Summarized Operations in Active Fields for September, 1937

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	268	256	57	93	3500-3700	2	40	Rotary
Duval County	75	61	18	59	1554-2900	2	22	Rotary
Archer County	34	17	3	11	660-1800	1 or 2	40	Rot.-Cab.
Panhandle	79	79	58	182	1700-3900	2	40	Rotary
Refugio County	15	14	4	13	4900-5900	2	38	Rotary
Nueces County	40	36	20	59	3922-5878	2 or 3	21-54	Rotary
Winkler County	49	48	9	47	2850-3450	2 and 3	30-38	Rot.-Cab.
Talco Field	46	45	8	36	4230-4361	2	16-24	Rotary
Oklahoma								
Oklahoma City	6	5	1	7	6450-6682	3	39	Rotary
Fitts Pool	31	27	6	31	1800-4488	2 or 3	38	Rotary
Osage County	18	13	3	28	380-2850	2	37.5-40	Rot.-Cab.
Kansas								
Russell County	43	38	10	57	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	30	24	7	40	3222-4085	2 and 5	42-48	Rot.-Cab.
Reno County	9	7	3	15	3300-4375	2 and 5	42-48	Rot.-Cab.
Louisiana-Texas-Arkansas								
Rodessa	24	24	13	59	5950-6450	3	39	Rotary
New Mexico								
Lea County	52	52	24	118	3150-4030	3	30-34	Rot.-Cab.
California								
Kettleman Hills	5	5	5	11	8300-8730	3 or 4	40	Rotary
Wilmington	32	32	20	28	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for September, 1937

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1936 (In Barrels)
	September	August	September	August	September	August	September	August	September	August	
Arkansas	15	22	11	14	32	34	21	18	66	64	10,461,000
California	124	121	100	97	130	146	110	143	251	282	214,883,000
Colorado	7	2	2	1	....	....	2	3	40	41	1,670,000
Illinois	74	49	46	31	....	....	....	79*	....	62	4,452,000
Indiana	6	17	5	14	....	....	2	2	24	25	795,000
Kansas	255	283	198	228	273	267	76	73	435	417	58,226,000
Kentucky	73	41	46	32	....	....	16	13	79	78	5,653,000
Louisiana	111	148	90	113	134	135	53	48	278	255	79,980,000
Michigan	104	89	74	65	82	83	65	88	165	173	11,852,000
Mississippi	1	4	1	0	....	....	4	5	13	12	Gas Prod.
Montana	23	33	18	29	....	....	5	7	72	67	5,632,000
New Mexico	63	73	59	64	....	....	32	40	170	171	27,134,000
New York	....	....	....	....	....	....	....	....	....	....	4,637,000
Ohio	146	179	104	133	....	....	65	81	214	222	3,834,000
Oklahoma	203	260	154	193	217	226	59	60	424	420	206,082,000
Pennsylvania	....	....	....	....	....	....	....	....	....	....	15,830,000
Texas	1405	1467	1142	1159	1526	1614	491	503	1782	1862	391,097,000
West Virginia	93	97	81	76	....	....	38	34	201	187	3,903,000
Wyoming	8	18	6	8	....	....	12	16	71	75	13,650,000
Total	2711	2903	2137	2257	2394	2505	1051	1213	4285	4413	993,942,000

**Including 41 rigs standing and 25 rigging up.



The bringing in of the Otto Durbin No. 1 on March 28, 1935—a 3594 barrel gusher—marked the Crystal boom which established Michigan among the leading oil states of the country. Five million cubic feet of gas preceded the gusher, blowing off the control head and spraying oil over the surrounding area. State Police patrolled the roads and the nearby school was closed partly for safety and partly to celebrate the good news.

Michigan has every right to celebrate its outstanding progress as an oil producing state. Moreover, out of Michigan came the Dowell method of *Inhibited* Acidizing which has done more to boost production in the areas served than any other development since the perfection of the rotary drill.

NOW AT BORGER, TEXAS AND AT STAMFORD, TEXAS

All inquiries for these two stations can be directed either to the stations or to our office at Wichita Falls, Texas.

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SHELBY, MONTANA • SHREVEPORT, LOUISIANA • STAMFORD, TEXAS • STONEWALL, OKLAHOMA • TULSA, OKLAHOMA • WICHITA, KANSAS • WICHITA FALLS, TEXAS

OIL AND GAS WELL CHEMICAL SERVICE

Progress of Major Pipe Line Work

THE 220-mile 8-in. gasoline pipe line being constructed in the East by the Keystone Pipe Line Company and the Buffalo Pipe Line Company, subsidiaries of the Atlantic Refining Company, will be completed the latter part of October, it has been announced by officials of the companies. The new line will connect Buffalo and Rochester, New York, with the existing system, tying into the Keystone's line at Williamsport, Pennsylvania. That portion of the line extending northwest from Williamsport to the New York-Pennsylvania border will be operated by the Keystone Pipe Line Company, the remainder by the Buffalo Pipe Line Company.

T. R. Jones and W. G. Hanrahan, of Dallas, Texas, are the construction contractors.

•

The pipe line being constructed by the Standard Oil Company of Louisiana from Baton Rouge to the Roanoke and Jeanerette field in South Louisiana is expected to be completed the latter part of this month, it has been announced. It is a combination 6-in., 8-in., and 10-in. electric-welded line and will have a total capacity of approximately 20,000 bbl. daily. Three pumping stations will be erected, one at Jeanerette, one at Roanoke, and one at Sunset.

•

A 20-in. gas pipe line to extend from the Otis-Albert gas field in Rush and Barton counties, Kansas, to Kansas City, Kansas, a distance of approximately 250 miles, is being planned. The line will be laid for the Kansas Industrial Gas Company, now being organized.

The line will have a daily capacity of 80,000,000 cu. ft. and is expected to transport approximately 40,000,000 cu. ft. daily during the first year, which will be sold to industries. The Otis-Albert gas field is said to have a natural gas potential of 1,500,000,000 cu. ft., but a market at present for only 11,500,000 cu. feet.

•

The Humble Pipe Line Company has resumed work on its 6-in. line from Hobbs, New Mexico, to the Wasson and Bennett pools, West Texas. The Continental Oil Company has announced it will not lay its proposed line into the area.

•

The Gulf Refining Company's 6-in. line from Jefferson, Texas, area of the Rodessa field, connecting with the system in the field proper, has been completed. The length of the line is 12 miles. Prior to the laying of the line most of the production from the Jefferson area was shipped by tank car.

•

Completion of the Caddo Pipe Line Company's line to the Lisbon field, Louisiana, again gives that area a pipe line outlet for its crude oil, something it was without for a number of days following the withdrawal as a buyer of the Gulf Refining Company on October 1st. The field has 105 producing wells with a combined daily output of 16,000 barrels.

The Caddo Pipe Line Company is a subsidiary of the Grogan Oil Company, of which M. J. Grogan is president.

The Arkansas-Louisiana Gas Company is constructing a gas compressor station seven miles south of Daingerfield, Texas. Six 170-hp. engines are being installed with the machinery so arranged that additions easily can be made.

•

Clark Brothers Company, Olean, New York, have reported the sale of a Clark super 2-cycle angle compressor, in the new 6-cylinder 600-hp. size, to be used for gas booster service on the Canadian River Gas Company line. The company also has received an order for seven 250-hp. super 2-cycle horizontal twin compressor units to be installed in the Edmond field of Oklahoma for gas booster service.

•

The Phillips Petroleum Company has awarded a contract to the J. R. Stewart Company for laying a pipe line from the booster station of the Panhandle Eastern Pipe Line Company near Liberal, Kansas, to La Verne, Oklahoma. It will connect with Phillips' main line that extends from Borger, Texas, to Bartlesville, Oklahoma. The new line will carry casinghead gasoline from the Panhandle Eastern plant near Liberal, which heretofore has been shipped by tank car. The Phillips Petroleum Company will take the entire output of the gasoline plant, it is stated.

•

The 24-mile 3½-in. O. D. gasoline pipe line of the Humble Oil and Refining Company, laid from the company's new gasoline plant in the Dickinson field of Texas to Baytown, has been completed. The Latex Construction Company, Houston, was the contractor.

•

Petrol Corporation of California is to construct a 23-mile pipe line from the Gato Ridge field to Port Petrol, three miles south of Point Sal. It will be an 8-in. line and will have a maximum capacity of 25,000 bbl. daily. Two pumping stations will be erected, and at the terminal 250,000-bbl. storage capacity will be provided. From the terminal the crude oil will be transported by tankers.

•

Two new gas booster stations are being constructed in Wheeler County, Texas. The Northern Texas Utilities Company, with a combination 12-in. and 16-in. line from the Shamrock area to Wichita Falls, is erecting one of the stations. The other is being constructed by the Lone Star Gas Company, a 15-unit station for increasing the capacity of its 18-in. line to Wichita Falls and Fort Worth.

•

The M. A. R. Pipe Line Corporation will lay a line from the Saxet field to Corpus Christi, Texas. The main line will be of 6-in. pipe, and a 4-in. gathering system will be laid in the field. The line will tie into the terminal of the Export Oil Storage Company at Corpus Christi. The latter will increase its storage capacity at the terminal by 250,000 bbl., making the total 500,000 barrels.

MORE THAN 750 CREW MONTHS SEISMIC REFLECTION SURVEYING EXPERIENCE IN MANY SECTIONS OF THE UNITED STATES, IN CANADA, POLAND, ROUMANIA, HUNGARY, NEW ZEALAND, LITTLE AMERICA, ARGENTINA AND TRINIDAD, RESULTING IN LOCATION OF 32 ORIGINAL OIL FIELDS NOW PRODUCING... AND MANY MORE AS YET UNDRILLED.

Seismograph Service Corporation

WORLD-WIDE EXPERIENCE

WE HAVE MANUFACTURED 42 COMPLETE SEISMIC INSTRUMENTS. MORE OF OUR EQUIPMENT IS IN USE THROUGHOUT THE WORLD THAN ANY OTHER MAKE.

WRITE FOR BOOKLET

Without this **PIPE LINE RADIO**
It's as hard to Locate a **PIPE LINE as**
to see Sambo digging in a cemetery at midnight!

To locate Sambo we won't give you any advice, but to locate your pipe line, your competitor's pipe line or anybody's pipe line, here's the answer...

¼ AS HEAVY — 5 TIMES AS SENSITIVE

Receiver complete as shown, weighs but 7 pounds. It may be carried all day without fatigue — no back-breaking packs to carry — no lines to trip over. Everything is complete in one hand, except phones worn on head. Transmitter complete with batteries weighs 10 pounds.

Complete with spears and leads, spare parts, tools, carrying cases and headphones, the price is **$197.50**

- *With this Pipe Line Radio you can accurately follow a designated line underground ...*

WITHOUT CONFUSION FROM PARALLEL LINES, OR CROSSINGS

- *You can quickly and within inches tell the depth line is buried at any point.*
- *Laterals are easily located and changes in diameter of line are easily detected.*

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The Month's Activities In Refining

Percent Refinery Capacity Operated

Western Division, 81.7 Percent **Central Division, 79.9 Percent** **Eastern Division, 87.1 Percent**

THE Columbian Carbon Company has started construction of a carbon black plant in the Saxet field, Texas, approximately nine miles west of Corpus Christi. Tail gas from the Southern Minerals Corporation's natural gasoline plant will be utilized. The plant is expected to be completed within six months. H. J. Glaxon is in charge of the work.

●

An oil refinery to cost between $500,000 and $1,000,000 is under construction at Cotton Valley, Louisiana, by the Octane Oil and Refining Company of Longview, Texas. Work got under way in September after Sylvester Dayson, president of the company, signed one of the contracts sponsored as part of Governor Richard W. Leche's industrial expansion program for Louisiana, granting a ten-year tax exempt period.

The refinery will have a capacity of 3000 bbl. daily and provide employment for several hundred persons, according to Dayson.

●

The Standard Oil Company of California is adding a new solvent refining plant at its Richmond, California, refinery. The plant will include a Duo-Sol refining unit and a methyl-ethyl-keystone dewaxing plant and will increase the refinery's production of lubricating oils of high viscosity index. The plant will be completed in June, 1938. E. B. Badger and Sons Company are the contractors for the dewaxing plant, licensed under The Texas Company patents. The Duo-Sol process is licensed by Max B. Miller and Company, who also is the construction contractor for the unit.

Other new construction work at the plant includes the erection of a hydrogenation unit, which is expected to be in operation by the first of the year. This unit is licensed by the Hydro Patents Company.

●

The Continental Oil Company has underway a construction program that will increase the capacity of its Denver, Colorado, refinery from 2000 to 4000 bbl. daily. New equipment will include heating units, fractionating towers, pumps, additional storage for crude and refined products, and additional trackage facilities.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks

Week Ended October 2, 1937

A.P.I. Figures

(Figures in Barrels of 42 Gal. Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	554,000	82.8	18,483	15,716
Appalachian	88.4	112,000	86.8	2,510	933
Ind., Ill., Ky.	92.4	449,000	91.8	10,059	7,131
Okla., Kans., Mo.	84.7	297,000	77.5	6,083	3,825
Inland Texas	56.6	139,000	69.2	1,702	1,703
Texas Gulf	95.7	778,000	97.6	7,892	9,995
La. Gulf	96.6	139,000	82.7	1,602	3,140
No. La.-Ark.	63.7	42,000	72.4	425	401
Rocky Mt.	67.7	57,000	91.9	1,294	733
California	90.9	533,000	71.4	11,686	70,149
Reported	89.0	3,100,000	83.7	61,736	113,726
Est'd Unreported	.....	300,000	.....	3,530	3,350
*EST'D TOTAL U.S. Oct. 2, '37	.....	3,400,000	.....	65,266	117,076
*EST'D TOTAL U.S. Sept. 25, '37	.....	3,455,000	.....	65,620	116,472
U. S. B. of M. *Oct. 2, 1936	.....	**3,005,000	.....	57,791	112,638

*Estimated Bureau of Mines' basis.

**October, 1936, daily average.

Clark Brothers Company, Olean, New York, report the receipt of an order for 15 250-hp. twin-cylinder super 2-cycle horizontal engine-driven compressors to be used in the natural gasoline plant in the Edmond field, Oklahoma.

●

Six additional Perco Copper Sweetening units will be installed by the Phillips Petroleum Company in their Panhandle, West Texas and New Mexico areas. One of these, a liquid copper sweetening system will be installed at Phillips' Judkins natural gasoline plant at Odessa, Texas, and will, for the present, process only natural gasoline. When the thermal polymerization unit now under construction at Judkins is completed, all products will be copper sweetened.

Five more Perco units are to be constructed at Phillips' Alamo refinery at Borger, Texas, to process its entire output of polymerized, cracked, vapor-recovery, and straight-run gasolines and naphtha distillates. These new units are necessary because of the completion of additional thermal polymerization stills, and a general increase in output at this refinery, it is stated.

The Phillips Petroleum Company began using the copper sweetening process on a plant scale several years ago. The Perco Copper Sweetening Process, a development of the Petroleum Engineering Research Company of Bartlesville, Oklahoma, is now being used by more than a score of refiners and natural gasoline manufacturers throughout the country; more than 50 units are now in operation treating all types of sour distillates, the manufacturers state.

Construction of the six Phillips' plants is to begin immediately upon receipt of materials.

●

A natural gasoline plant will be erected in the McCampbell field of Aransas County, Texas, by the Warren Petroleum Company, Tulsa, Oklahoma, starting about November 1st. It will be of the absorption type and will have a daily capacity of approximately 80,000,000 cu. ft. of gas.

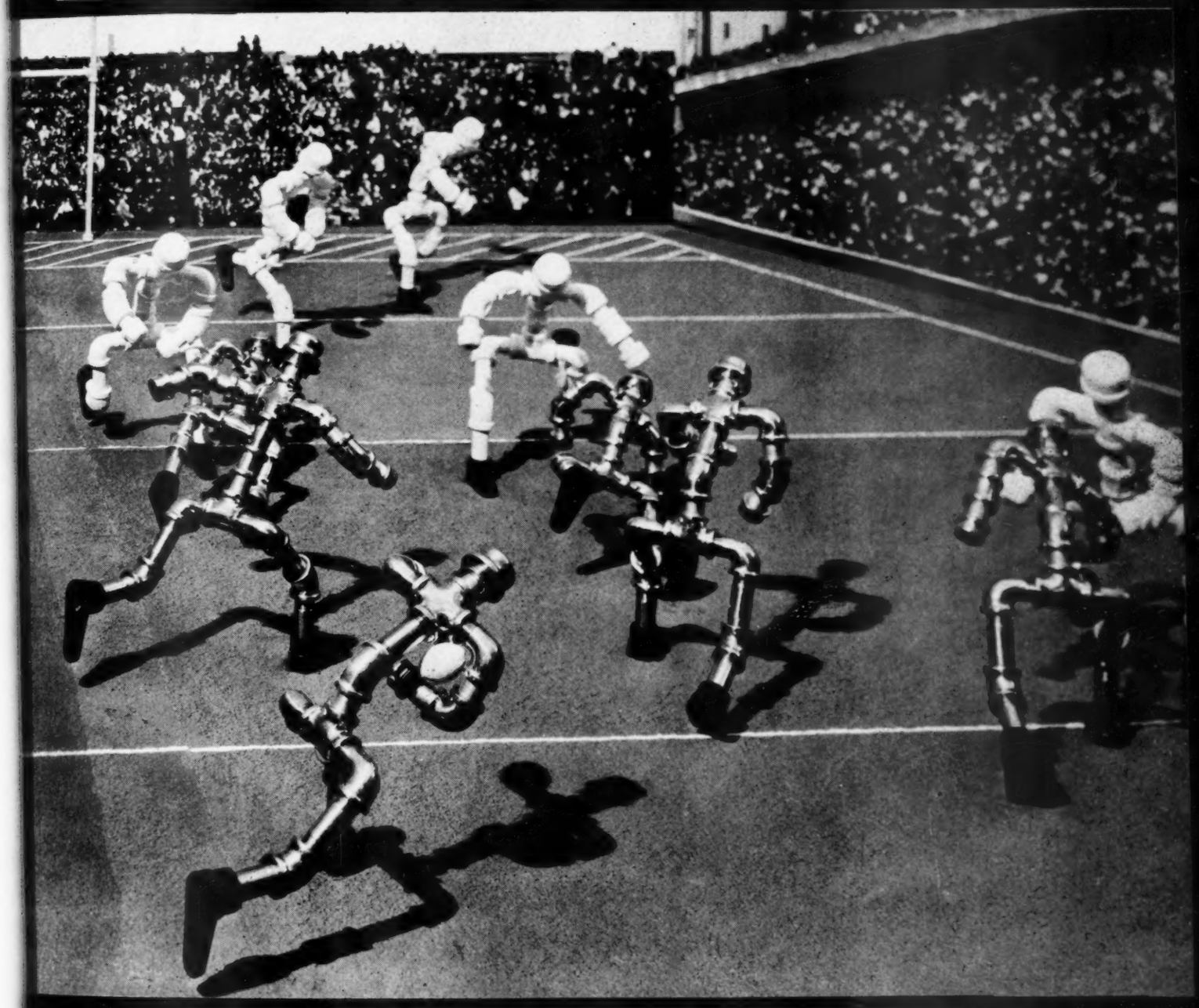
●

The General Petroleum Corporation has awarded a contract to the Lummus Company of New York City for the erection of a combination viscosity breaking and cracking unit at its Torrance, California, refinery. The unit will have a capacity of 14,000 bbl. of crude oil daily.

Pictorial PETROLEUM

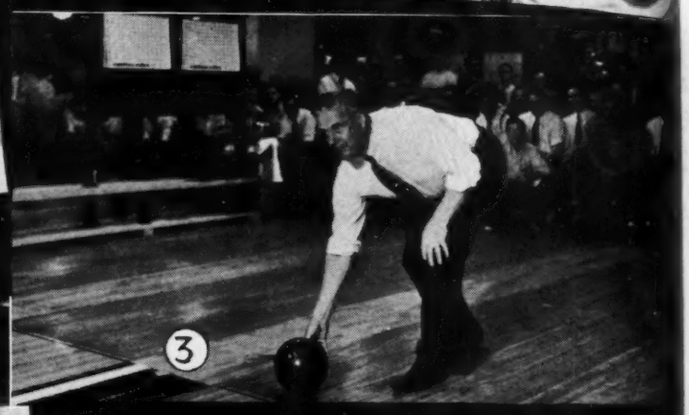
OCTOBER, 1937

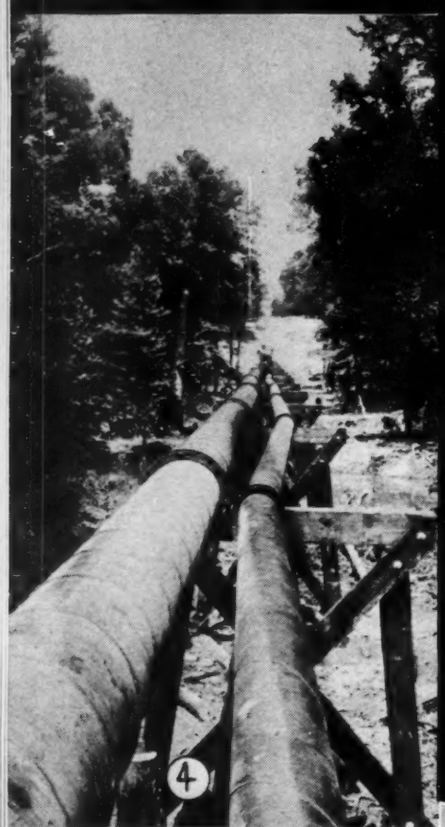
A REGULAR FEATURE OF THE PETROLEUM ENGINEER



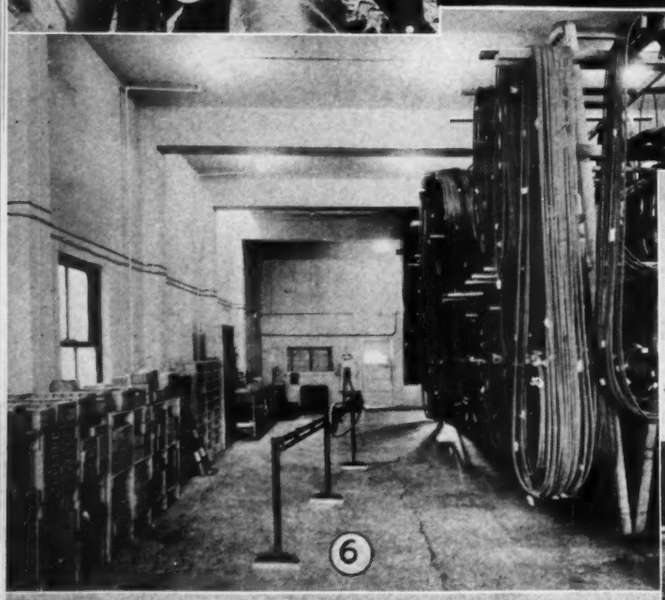
CRANE COMPANY LAUNCHES GRID SEASON

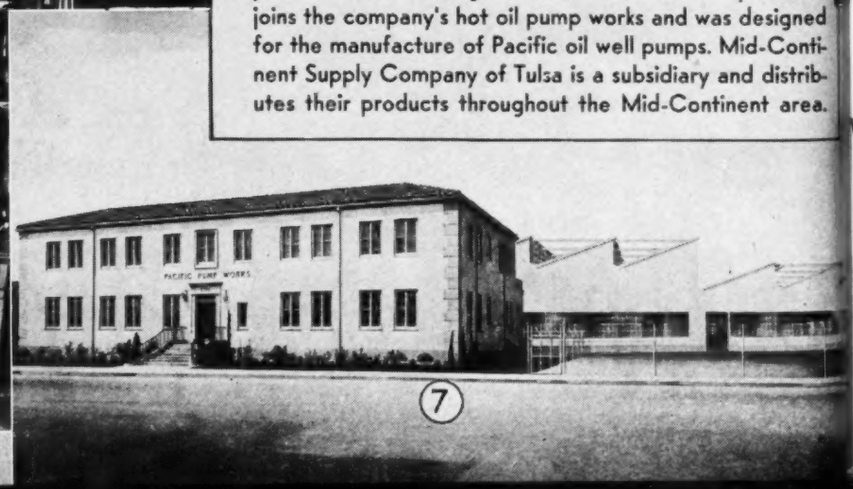
From rubber toe to helmeted top these hard driving gridiron huskies were constructed in their entirety from brass fittings and other accessories in the stock of Crane Co., Chicago. They have been placed in a realistic setting and the display now is touring the country, with the season ending in Los Angeles at the time of the annual football classic, the Pasadena Rose Bowl game.



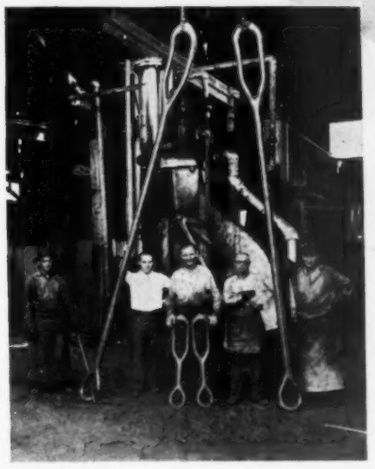


1. A Phillips Petroleum Company group taken at Rodessa, Louisiana. Back Row (left to right): C. E. McKenna, petroleum engineer; Wade Ramzy; F. F. Loving, district petroleum engineer. Front Row: C. S. Wayman, petroleum engineer, and N. E. Dixon, purchasing agent.
2. Taken at Borger, Texas, the group (left to right): Frank A. Kright, petroleum engineer; Bob Gerner, petroleum engineer; and L. T. Hoover, assistant superintendent; all with Phillips Petroleum Company.
3. J. F. Lincoln, president of The Lincoln Electric Company, Cleveland, Ohio, opens the 1937-1938 bowling season for the Lincoln 24-team league composed of 150 of the company's employees.
4. Spiral pipe, 24 inch and 14 inch, with Dresser couplings on a trestle in the Rodessa, Louisiana, district. It is part of a Phillips gasoline plant gathering system.
5. M. G. Rowe, shop manager for Hunt Tool Company at Jennings, Louisiana.
6. Interior view of the Gates Rubber Company sales division at Tulsa, Oklahoma. T. D. Williamson is district representative.
7. Pacific Pump Works' new factory, one of the most modern in building and design, recently completed and placed on production at Huntington Park, California. The plant adjoins the company's hot oil pump works and was designed for the manufacture of Pacific oil well pumps. Mid-Continent Supply Company of Tulsa is a subsidiary and distributes their products throughout the Mid-Continent area.





CREWS like to work FASTER WITH BJ TOOLS



Above: Large or small, BJ Tongs lend themselves to rhythmic, safe handling — a BJ Snapon Tubing Tong, and a BJ 10" O.D. Rotary Tong. See picture (1) below for the 10" tong in service.

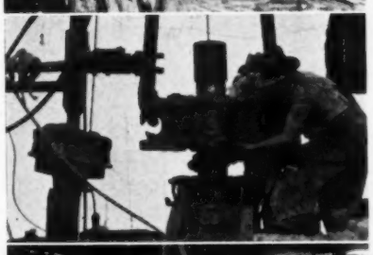
Whether you need BJ Weldless Links in the 14-foot size for deep drilling, or the 4-foot size for pulling long strings of tubing — they provide a safety note that will be appreciated by your crews.

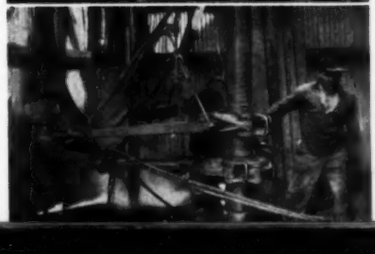
The perfect balance — easy handling — the freedom from danger assured by BJ Tongs, Elevators and Hooks — bring rhythm of motion to the derrick floor. In Burma or Bahrein — in California or on the Gulf Coast — fast moving crews work in rhythm with a swiftness possible only with BJ Drilling and Production Tools. Are you providing *your* crews with this modern safety and convenience?

BJ EXTRA HEAVY ROTARY AND CASING TONGS . . .

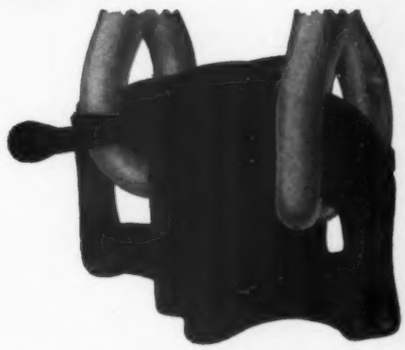
retain all of the easy-handling features of lighter weight BJ Tongs, plus new, large handles, and a latch with handle. Their great strength makes them safe for use on Full Hole tool joints, and for breaking-down or making-up drill collars and core barrels, but they are easily operated by one man.

(At right) (1) In Burma they know the value of rhythm when they use 8 BJ Tongs every round trip—one set each of 5", 6", 8" and 10". A close-up of a 10" tong (for 10¾" tool joint) is shown in picture set at angle above, right. (2) In Texas, as casing is set with a BJ Side-Door Slip Casing Elevator. Although strong enough for any string, one man in the derrick can "swing it." (3) They use turbans instead of steel hats, but some of these native Indian crews "have got rhythm" when they take hold of BJ Tongs. (4) This crew is moving so swiftly that a fast lens will not "stop 'em"—note that BJ Tongs are contributing to fast work on this California well.





Look up any modern derrick, and the chances are 10 to 1 that you will see a BJ Triplex Hook playing its part in speeding up the work safely.



BJ Type A CENTER LATCH DRILL PIPE ELEVATOR

This is the last word in elevators for Heavy Duty Service. Check these features: the fully heat treated body withstands upsetting by tool joints; the hidden latch is safe from accidental opening by the elevator link when "tailing in" a joint; the smallest size elevator takes 2¾" BJ Weldless Links; long, guarded horns prevent injuries and provide a quick, safe grip for fast operation; the standard grease gun connection permits easy lubrication and insures longer life of hinge pin; permanently attached link retainers hold the links safely and provide additional strength; the horizontal latch is positive and easy to operate, but is not affected by vertical shocks and jars.

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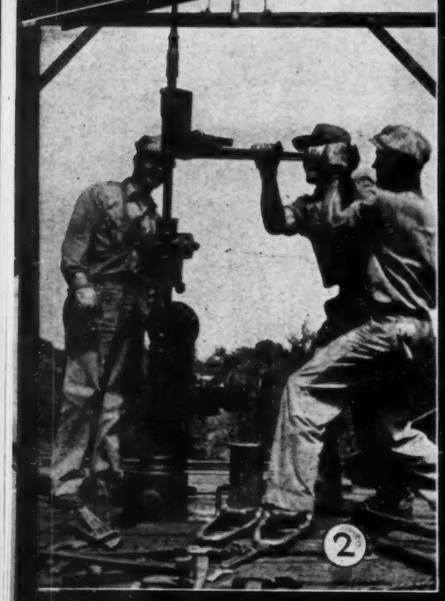
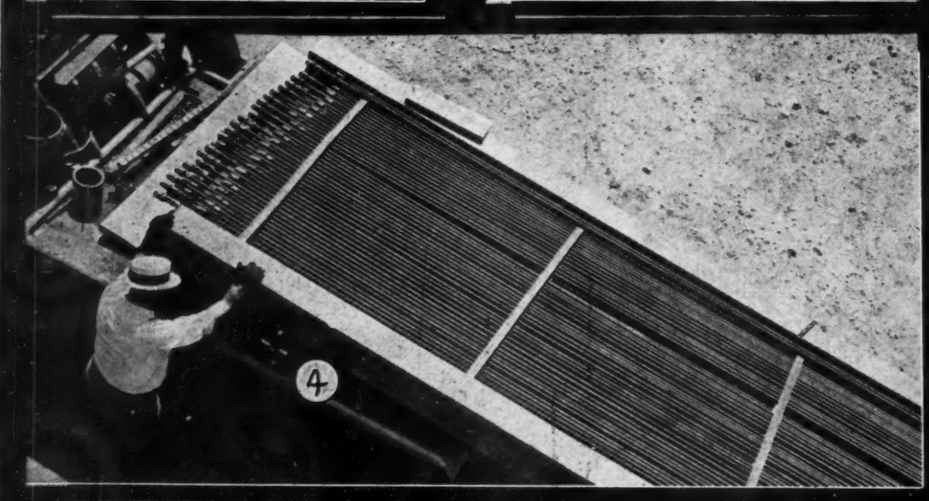
FORT WORTH • LOS ANGELES • NEW YORK

A PREVIEW OF NEW TALKING PICTURE

"Progress in Sucker Rods"

Photographs Courtesy The S.M. Jones Company





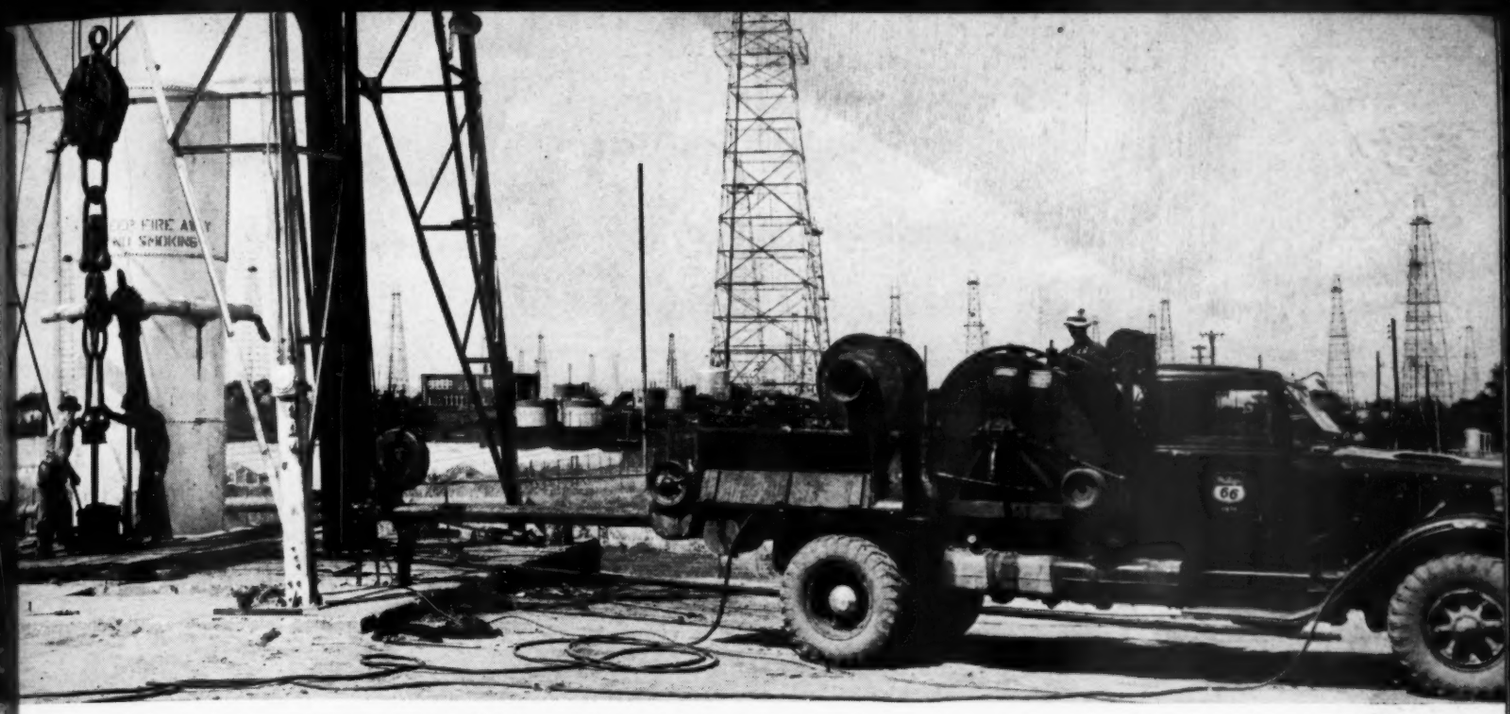
1. Progress in sucker rods is exemplified in this new talkie by the picture of P. C. Jones holding the first iron sucker rods patented by his father in 1891.

2. Back on the pump—even the rod crew gets a thrill when they have fished for the rods and the engineers have fished for facts.

3. The use of the dynamometer marks progress in sucker rods. Like the stethoscope to a doctor it tells the expert important facts about pumping conditions.

4. Careless handling of rods in the field is becoming a thing of the past with pictures like this as guide and inspiration.

5. Rodney crashed the movies in Oklahoma and under expert motion picture direction, shows rod crews what not to do with sucker rods.



The largest producing company in the Oklahoma City field chose Franks winches, because they complete rod and tubing jobs in less time from warehouse to location or from location to location.

FRANKS Winches Acknowleged the FASTEST — MOST EFFICIENT — MOST ECONOMICAL Units in the Oklahoma City Field

In the Oklahoma City field Franks Winches used by the largest producing company in the field in servicing several hundred wells, are generally acknowledged the FASTEST, MOST EFFICIENT, and MOST ECONOMICAL winch units in the area.

Franks units are the fastest for location to location moving. Fastest anchorage. Fastest rig-up. Save shutdown time. Exclusive anchorage facility saves thousands of dollars. Employed by nearly every major oil company in the Mid-Continent and Gulf Coast areas. Over seven hundred winch units built and every one still giving satisfactory service today.

●

Franks final friction drive truck motor driven well servicing winch units are built in sizes to handle wells from the shallowest to the deepest. They mount upon and take drive from all makes of trucks from 1½ tons to the most powerful. Write for complete information or see the Composite Catalog.

A battery of Franks Giant Model truck motor driven final friction drive well-servicing winches used by one major company servicing several hundred wells in the Oklahoma City field.

FRANKS SEVEN EXCLUSIVE ADVANTAGES

1. FASTEST ANCHORAGE AND LEAST HOLD-DOWN EXPENSE. Just back Franks truck motor driven winch back into location and anchor at any point on or inside of derrick or mast by means of horizontal telescoping boom. No floor block necessary.
2. FINAL DRIVE FRICTION CLUTCH. Eliminates shock loads and therefore keeps repair to unit at minimum.
3. MOUNTS UPON ANY TRUCK 1½ to 10 TONS. Easily installed at little cost. Power take-off proven success with over 700 units in field, all of which are still operating.
4. FULL TRUCK CAPACITY AVAILABLE. Winch directly behind cab leaving bed for tools or general truck use.
5. LESS WEIGHT AND BETTER DISTRIBUTION ON TRUCK TIRES.
6. LOWER CENTER OF GRAVITY.
7. HANDLES MORE JOBS IN SAME TIME, due to quicker anchorage facility and greater maneuverability.

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS

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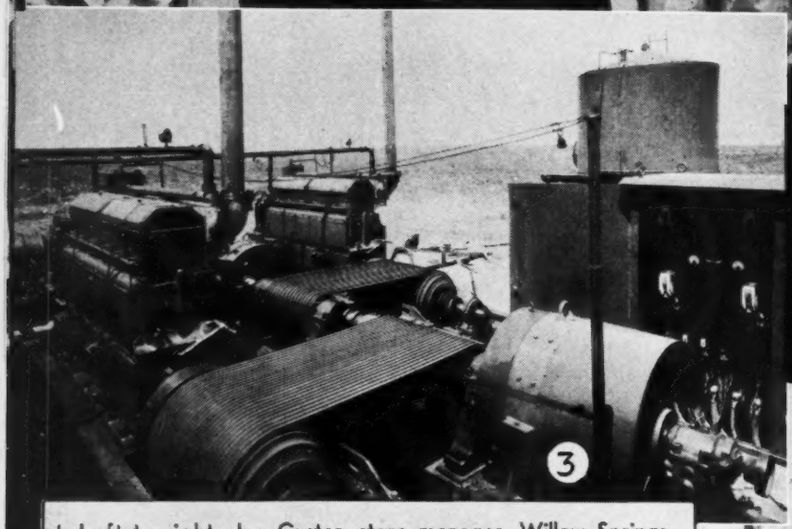
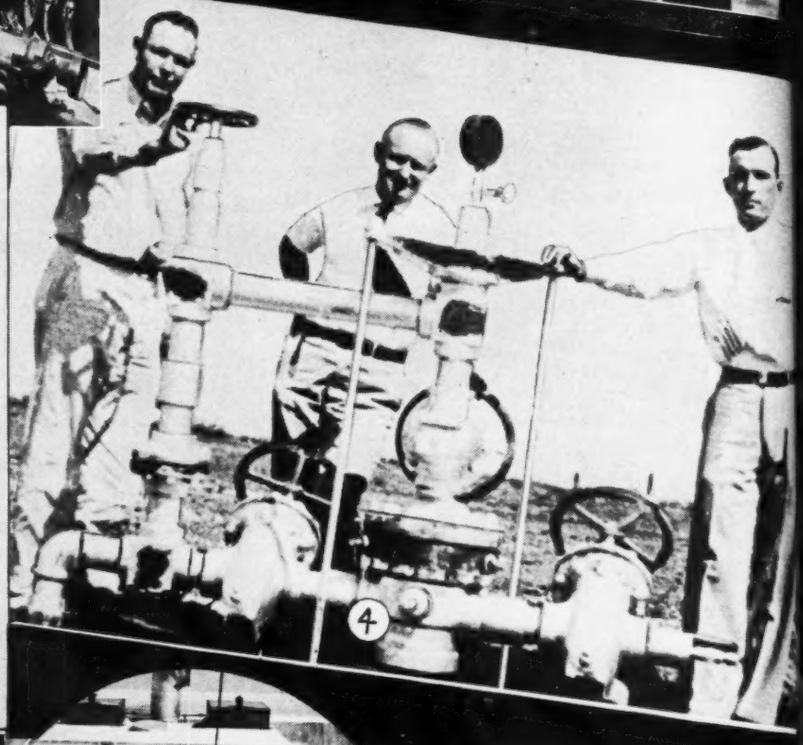
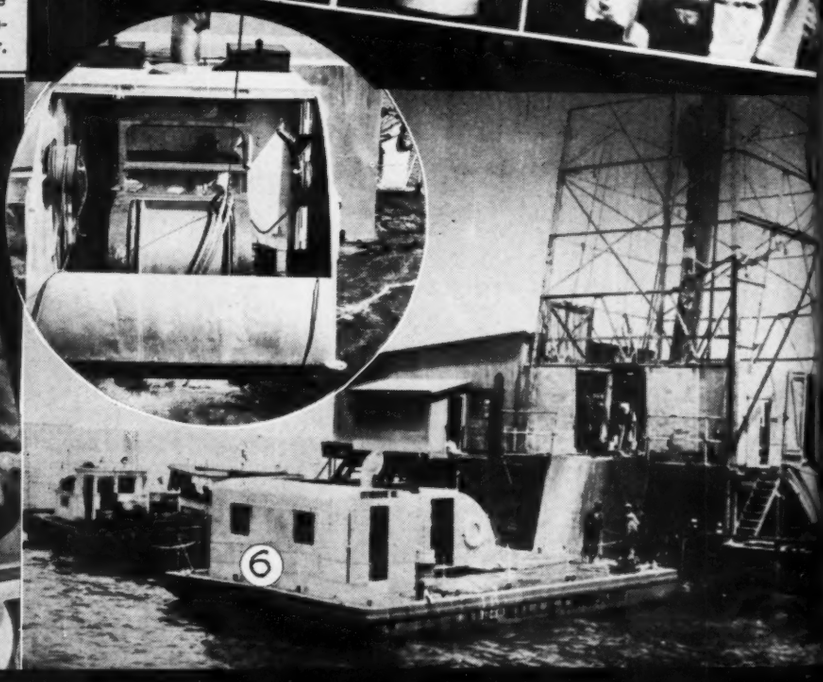


1. Left to right: Joe Custer, store manager, Willow Springs, Texas; A. A. Moody, vice president and general manager, St. Louis, Missouri; and Paul Carpenter, field man at Rodessa, Louisiana. All are with Jarecki Manufacturing Company.
2. J. B. "Jim" Graham, assistant general manager of sales for National Tube Company, with a 25-lb. ling landed at Freeport, Texas.
3. Field installation featuring Dayton Cog-Belt Drives in actual field use.
4. Three well-known West Texas oil men grouped at an installation of an Oil Center Tool Company Christmas tree. Left to right: O. F. Barton, superintendent for American Liberty Oil Company, Odessa; C. L. Billburg, field representative for Atlas Supply Company, Odessa; and Walter Burke, Oil Center Tool Company representative in the West Texas area.
5. Paul Cavins (left), general manager of The Cavins Company, Long Beach, Calif., and Harry D. Huskey, drilling superintendent for Iraq Petroleum Company at Kirkuk, Iraq.
6. Ship Ahoy! The Lane-Wells gun perforator comes to the rescue of inundated oil wells along the Gulf Coast. One of Lane-Wells' newest developments is the "stream line" barge unit No. 1, operating in the coastal oil fields in Louisiana. The unit was built by Pennsylvania Shipyards for the first gun-perforating to be done by barge. Inset shows the operator.





7. Rotary Shot Hole Drill being loaded aboard the S.S. Del Norte, at New Orleans, and bound for Buenos Aires, Argentina. Manufactured in Tulsa, Oklahoma, by Engineering Laboratories, Inc., this equipment was supplied to Seismograph Service Corporation for service in the Argentine Government oil fields.

8. Houston Oil Field Material Company store at Odessa, Texas.

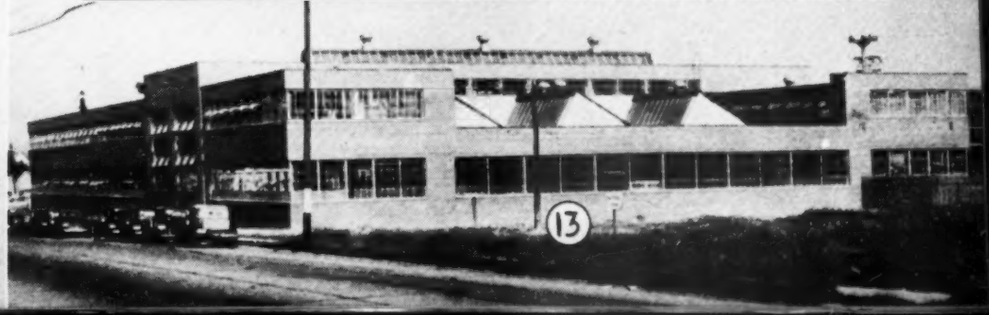
9. G. J. Turner (left), district superintendent at Borger; and Charlie Daniels, division superintendent at Amarillo; both on the Texas staff of Phillips Petroleum Company.

10. O. F. Jolly of the circulation staff of The Petroleum Engineer with a catch of kingfish, taken on a W-K-M Company fishing trip in Gulf waters.

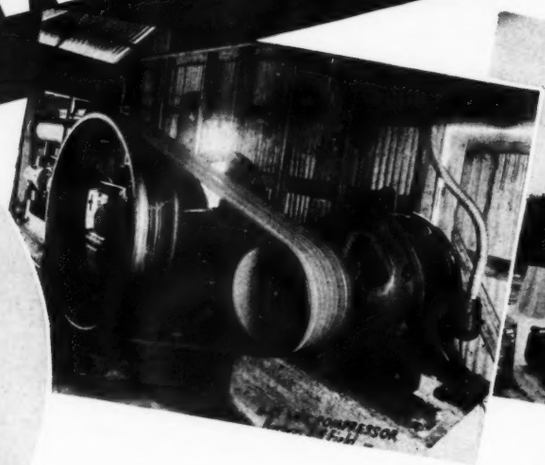
11. "Caterpillar" Thirty with winch, pulling oilfield equipment up mountain passes to site of well drilling near Elk View, West Virginia.

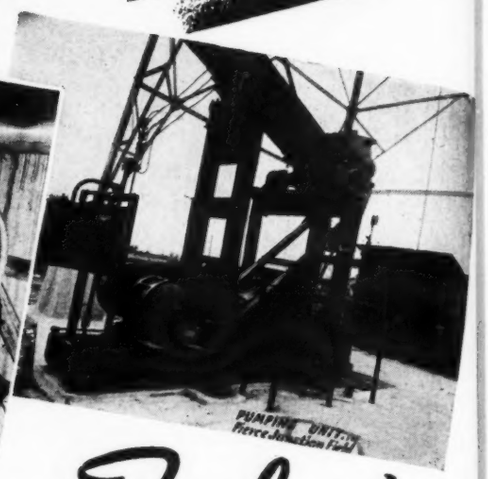
12. The original Bull Wheel from the discovery well of the Spindletop, Texas, field. The well was drilled by Lucas Myers in 1901. The well in the background is being drilled by his three sons who have spent their life in the oil business around Spindletop.

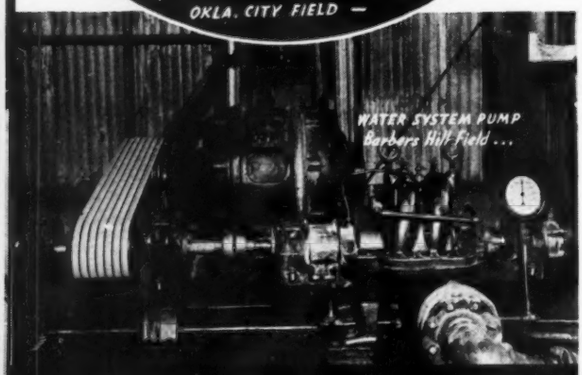
13. Chain Belt Company of Milwaukee has just completed erection of this new building at its West Milwaukee works to house the machine shops and the West Milwaukee offices.

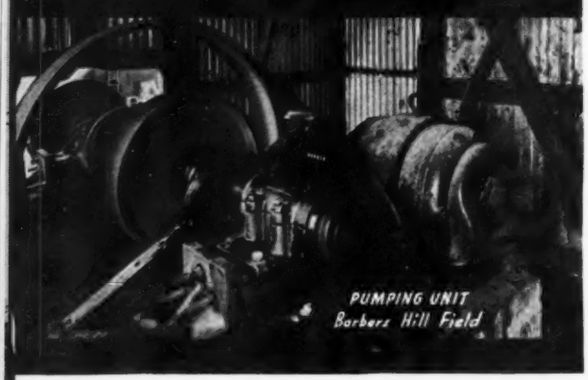


ELECTRIC POWER . . .









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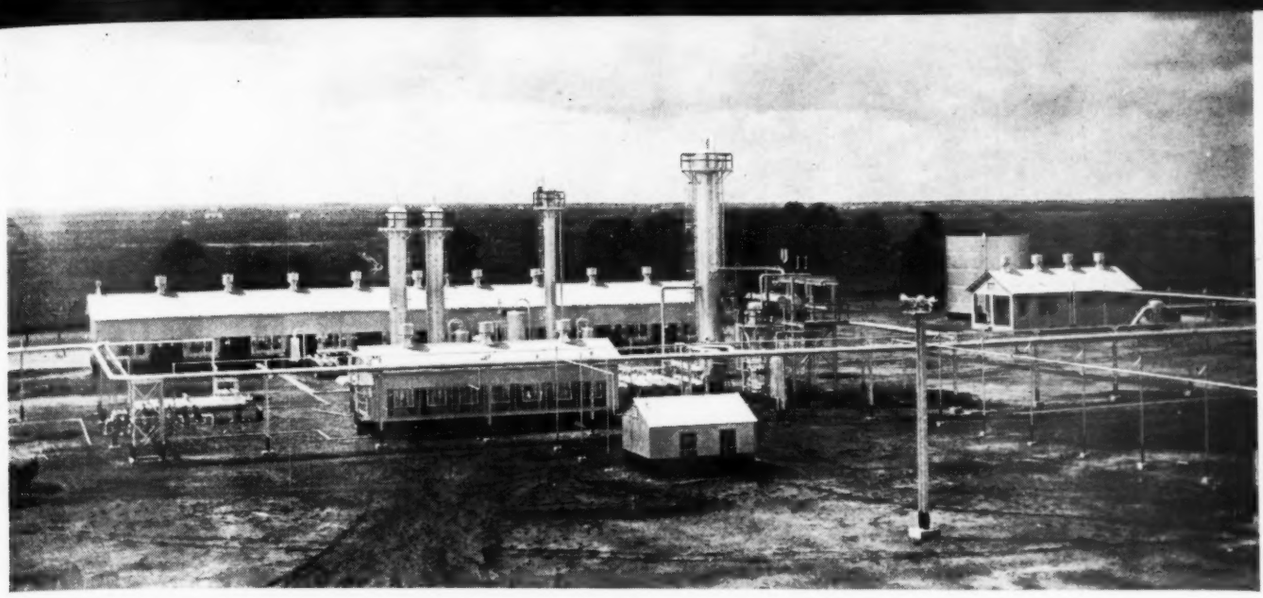


General view of compressor building, laboratory building, distillation equipment, distillation pump house, and plant shower and locker room

Care Exercised in Designing and Constructing Compression-Absorption Gasoline Plant

Unit in Tomball field of Harris County, Texas, has capacity of 35,000,000 cu. ft. of gas daily and is designed for 95 percent butane extraction

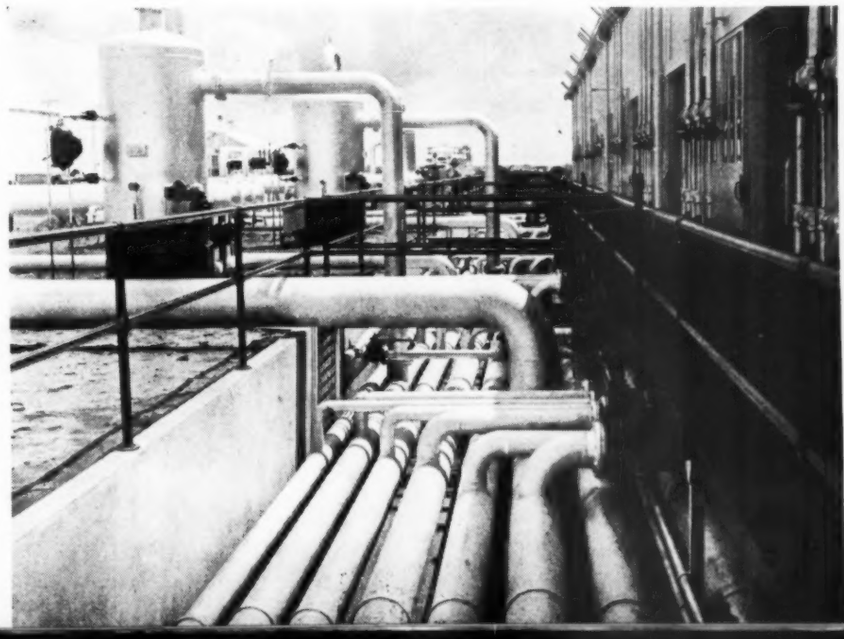
By FRANK H. LOVE

THE value of careful design and close attention to details in construction of a natural gasoline plant is exemplified by the new unit recently placed in operation at Tomball, Harris County, Texas, by the Humble Oil and Refining Company, a combination compression-absorption plant having a daily capacity of 35,000,000 cu. ft. of gas and designed for 95 percent butane extraction. The daily capacity of the compressor units is 10,000,000 cu. feet.

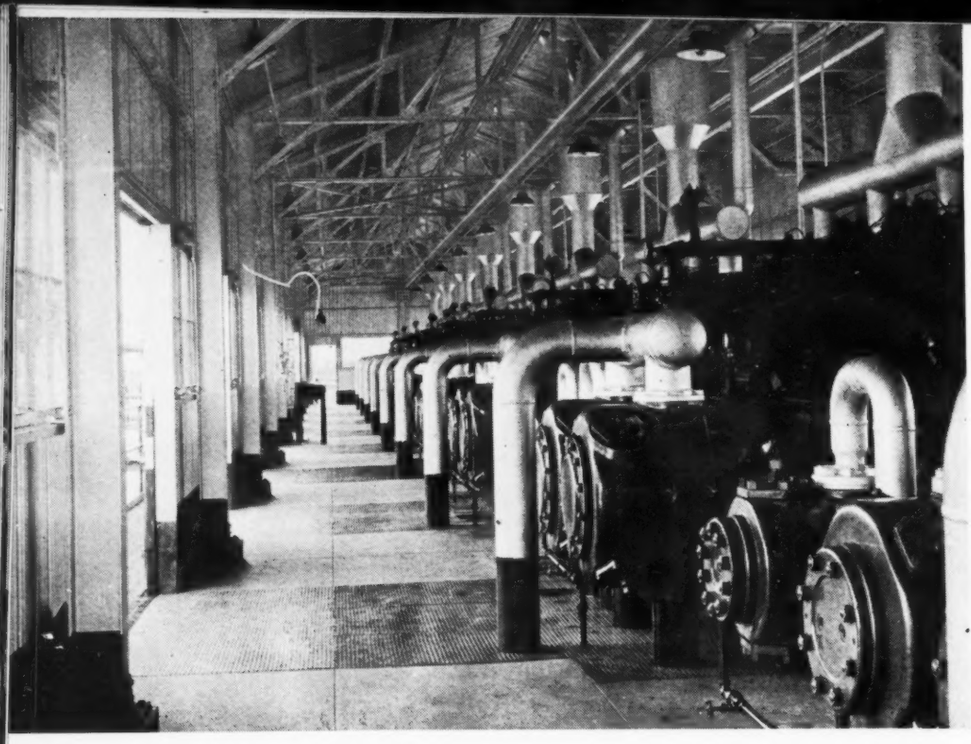
Earlier in the year the same company constructed a pipe line to provide certain Texas industrial centers with natural gas. The major portion of the supply is from the Tomball field and this gasoline plant is for the purpose of removing gasoline content before placing the gas in the line.

Low-pressure gas, that produced with oil, is utilized first in order to prevent wastage, the remaining consumer demand being provided from high-pressure gas wells. As the gas must enter the transmission system at approximately 825-lb. pressure, the low-pressure gas is boosted to that pressure by three stages of compression, and the pressure on the high-pressure gas is reduced. After the pressures of the two gases have been equalized their streams are joined and the gasoline content extracted by the absorption method. Some 200 oil and 50 gas wells are connected to the plant's gathering system.

Approximately one gal. of gasoline is obtained per 1000 cu. ft. of gas, a 90-100-lb. Reid vapor-pressure prod-



Pipe trench showing compressor intake and discharge headers, and fuel water headers. To the left can be seen the discharge scrubbers



Interior of compressor room, showing compressor side of units

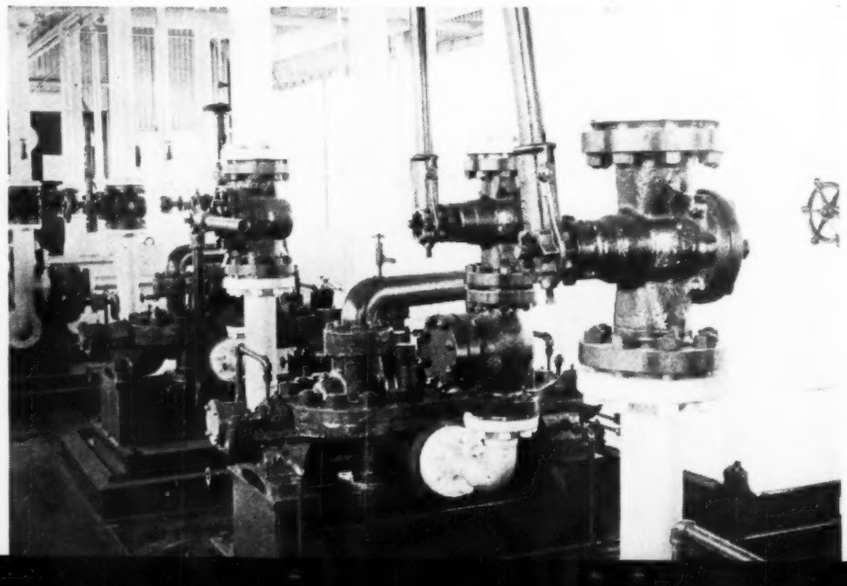
uct being manufactured. The gasoline, unstabilized, is pumped through a pipe line to the Humble's refinery at Baytown, a distance of 54 miles.

In designing and constructing the plant every effort was made to assure its operating efficiency and safety. Relief valves are installed in duplicate, automatically-operated magneto-grounding switches are provided to shut down the compressor units in event of too great a volume of fluid entering with the gas, all steam is condensed and returned to the boilers thus minimizing the amount of boiler make-up water required, all lines in the plant were doped and wrapped for protection against corrosion, all vessels such as absorbers, scrubbers, flash towers, the still rectifier, reflux accumulator, reabsorbers, storage tanks, etc., were built in strict accordance with the A.P.I.-A.S.M.E. code and so stamped, and during the manufacture of vessels, coolers, and distillation equipment the company maintained an inspector in the shops to assure use of the highest quality materials and workmanship, to mention but a few of the many features connected with the plant's construction.

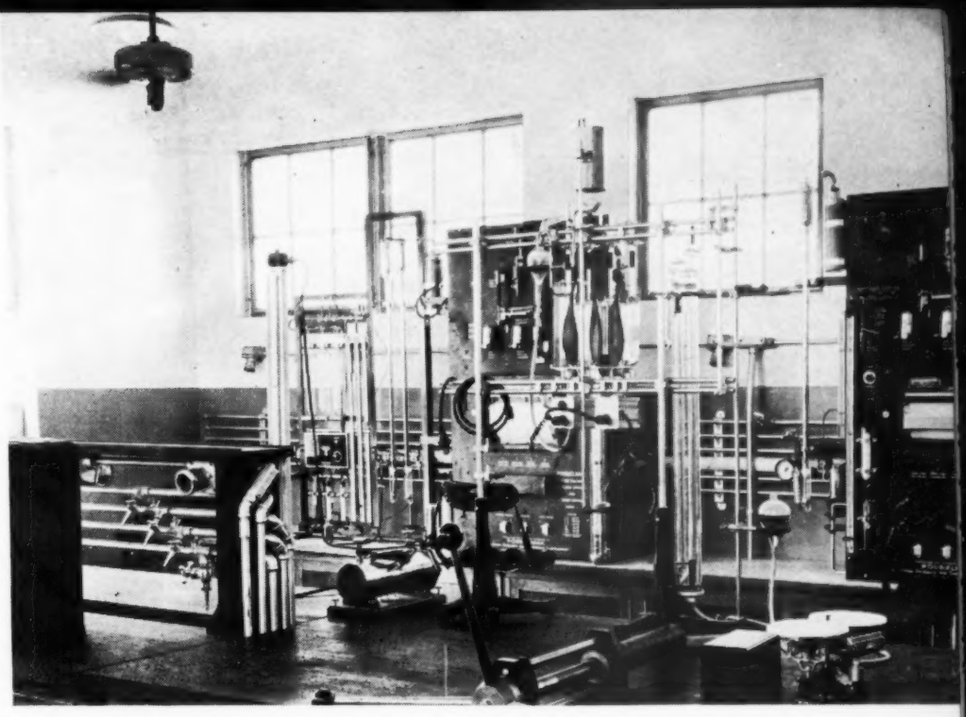
The gas produced with oil is brought to the plant by three main gathering lines, two 12 in. and one 16 in., being received at a pressure of 12 in. of vacuum. The gas entering the plant on the east side passes first through two 12-in. scrubbers 48 in. in diameter by 6 ft. high. The gas is then measured by an orifice meter, after which it goes to a combination gas scrubber and pulsation chamber, the latter being 60 in. in diameter by 6 ft. high. All scrubbers are equipped with drips and other means of separating liquid from the gas. As a safety measure the scrubbers also have mercoid switches that operate a warning device consisting of horn and lights. When liquid in the gas scrubbers reaches a predetermined level the warning signals are given. As an added precaution, and in event liquid should pass the first scrubbers, the pulsation chamber is equipped with a liquid-level controller operating an air pilot, which in turn operates a magneto-grounding switch. Should liquid reach a predetermined level the magnetos on the compressor units are shorted and the latter immediately shut down. The pulsation chamber also has as a part of its equipment, drips for blowing liquid from the chamber.

On the west side of the plant the gas is received through a 16-in. line, passing through a scrubber 54 in. in diameter by 6 ft. high and then a combination scrubber and pulsation chamber, 54 in. in diameter by 6 ft. high. These units are equipped with the same safety devices as those on the east side of the plant. After being scrubbed, all wet gas passes into a 16-in. line. From this line two 16-in. take-offs empty into a 12-in. suction header. The latter is situated in an open header trench alongside the compressor building. An 8-in. line off this 12-in. header takes the wet gas to the 15-in. cylinders of the compressor units, whence it is discharged at a pressure of 30 pounds. The 6-in. discharge lines from the 15-in. compressor cylinders are manifolded beneath the cylinders and carry the gas to a 10-in. discharge header in the pipe trench, whence it goes through a 10-in. line to three closed-type gas coolers, then through a scrubber 54 in. in diameter by 6 ft. high. A 10-in. line carries the gas to a 10-in. intermediate-stage suction header. From the header 6-in. lines lead into the 10-in. compressor cylinders. In the intermediate stage the gas enters the compressors at a pressure of 28 lb., having lost 2 lb. pressure on its passage through the coolers, and is discharged at a pressure of 185 pounds. From the intermediate-stage compressor cylinders the gas is discharged through a 4-in. line into an 8-in. header. From the latter an 8-in. line leads through three closed-type coolers to a scrubber 42 in. in diameter by 8 ft. high. An 8-in. line takes the gas to the 8-in. high-stage suction header, whence the 5-in. high-stage compressor cylinders take suction through a 4-in. line. Gas enters the high-stage compressor cylinders at a pressure of 183 lb. and is discharged at a pressure of 850 lb., a 3-in. line carrying the gas to a 6-in. header. This completes the cycle of the low-pressure gas prior to its being mixed with the high-pressure gas.

Nine vertical, V-type, 8-cylinder compressor units are employed to handle the low-pressure gas, each being complete within itself for 3-stage operation. Each has two 15-in. cylinders for low-stage compression, one



View in distillation pump house. Close-up of lean oil pump



Interior view of laboratory, showing automatic fractional distillation apparatus and miscellaneous equipment for investigation of natural gas and natural gasoline

10-in. cylinder for intermediate-stage compression, and one 5-in. cylinder for high-stage compression. The engines develop 300 hp. at 350 revolutions per minute. Each unit has eight power cylinders (with 12-in. stroke), and the necessary relief valves and bypasses are provided for each stage. As previously mentioned, the units are equipped with magnetos that will short out if (1) the engine overspeeds, (2) the cooling water becomes too hot, (3) the pressure in the lubricating system drops, or (4) liquid gets into any of the three intake scrubbers. Air intake lines to the engines are provided with oil-bath filters. The engines are equipped with air-cooled mufflers, and these have a tendency to improve air circulation in the building. Starting air is provided by two motor-driven 2-stage compressors having automatic start and stop features. The units are pressure-actuated. The motors are 5-hp. units of the explosion-proof type.

Lubricating oil is reclaimed by centrifuging. The centrifuging system consists of built-in pumps that draw the used oil from the compressor units. The oil is then heated to a temperature of approximately 180 deg. fahr. and, by means of centrifuging, cleaned of solids and water, after which it is pumped to a lube tank, of which there is one on each compressor unit.

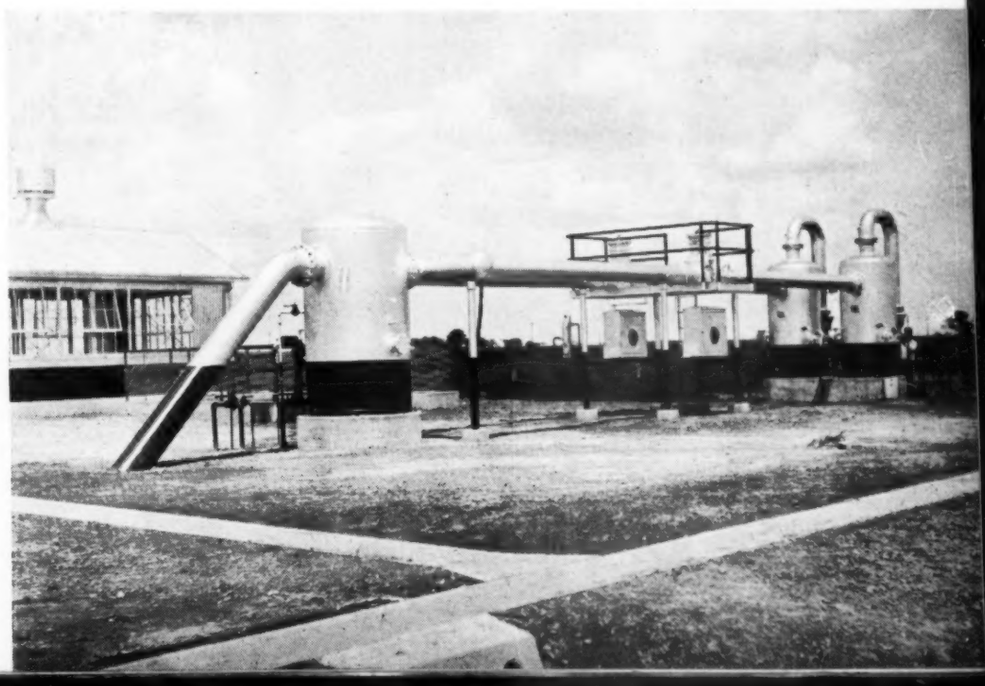
All piping and fittings in the compressor plant are of steel with the exception of the water service. Inside the building, the piping is laid in a trench, which is covered with iron plate, thus making the piping easily accessible. The gauge board in the plant records low-stage suction and high-stage discharge, and indicates low-stage discharge, intermediate - stage suction and discharge, and high-stage suction, as well as indicating the jacket water supply header pressure, and fuel gas supply header pressure.

High-pressure gas enters the plant from three main gathering systems composed of two 6-in. and one 4-in. lines. It is received at a pressure of 1500 to 1800 lb., and the gas from each line passes through a 15-pass gas-to-steam heater 42 in. in diameter by 22 ft. long operating on 5-lb. exhaust steam, where the temperature of the gas is raised to between 125 and 150 deg. fahr. to prevent freezing. These heaters are equipped with thermostatic controls that regulate the temperature of gas on the downstream side of the flow bean or choke valve. Leaving the heaters and flow beans the gas enters an elaborate manifold system from which two 4-in. extra-heavy lines run to secondary heaters situated near the distillation equipment. The two 9-pass secondary gas-steam heaters are 24 in. in diameter by 22 ft. long and are equipped with the same control mechanism as the 15-pass heaters. From flow beans on the secondary heaters the gas goes through a small manifold system and combines on the downstream side with gas from the compressor plant, being then ready for the absorption cycle.

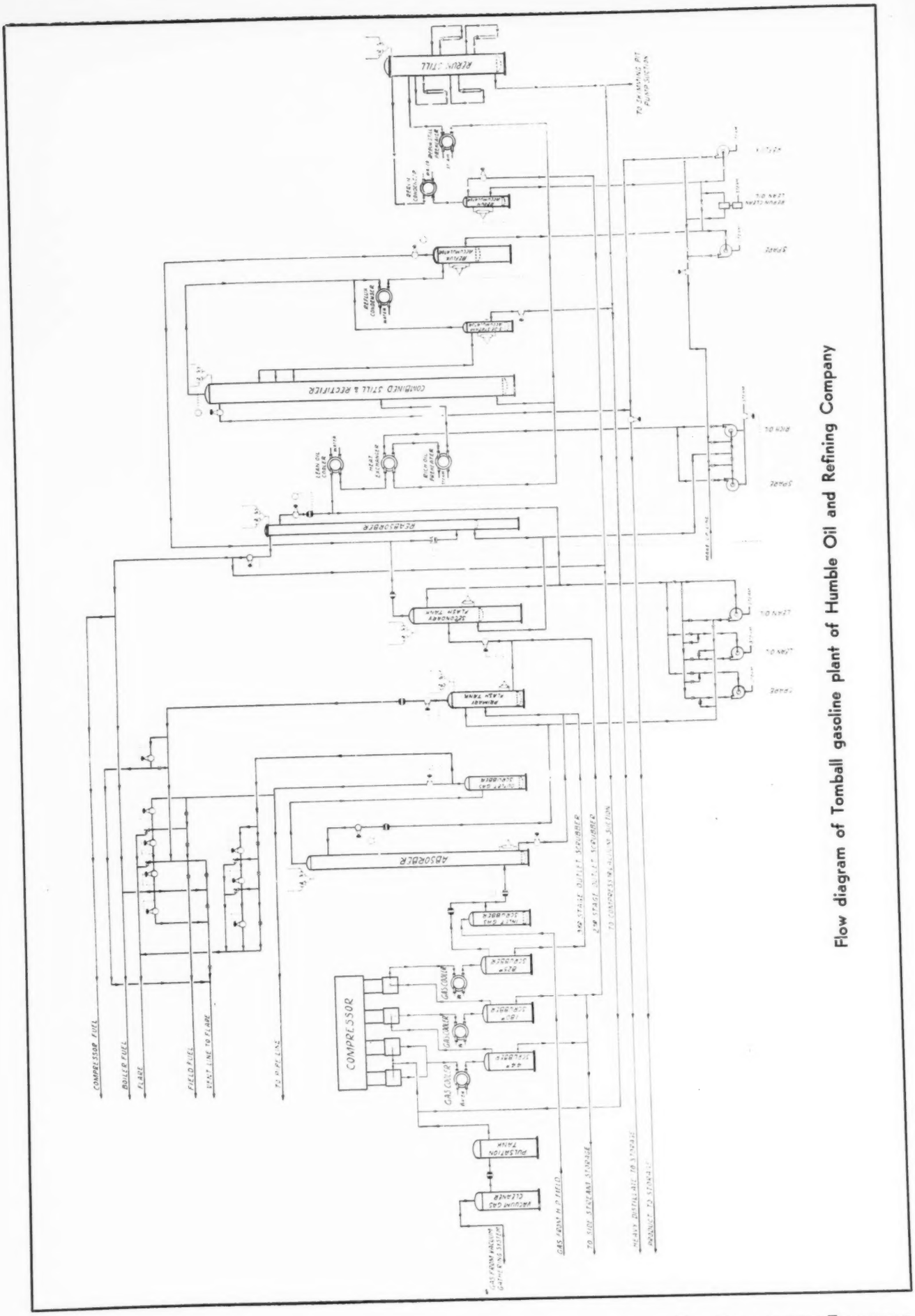
The combined gases enter two 20-tray main absorbers 42 in. in diameter by 43 ft. high, which are equipped with liquid level controllers and gauge glasses. Each absorber is designed for handling a load of 17,500,000 cu. ft. of gas each 24 hours and is capable of a considerable overload. Tracifier sections in the top reduce to a minimum the carry-over of mineral seal oil. Working pressure on the absorbers is 840 lb., and the vessels are stress-relieved, X-rayed, and otherwise built in strict accordance with the A. P. I.-A. S. M. E. code.

The two absorbers are arranged in such a manner that they can handle straight gas from the compressors, straight high-pressure gas, or a combination of the two.

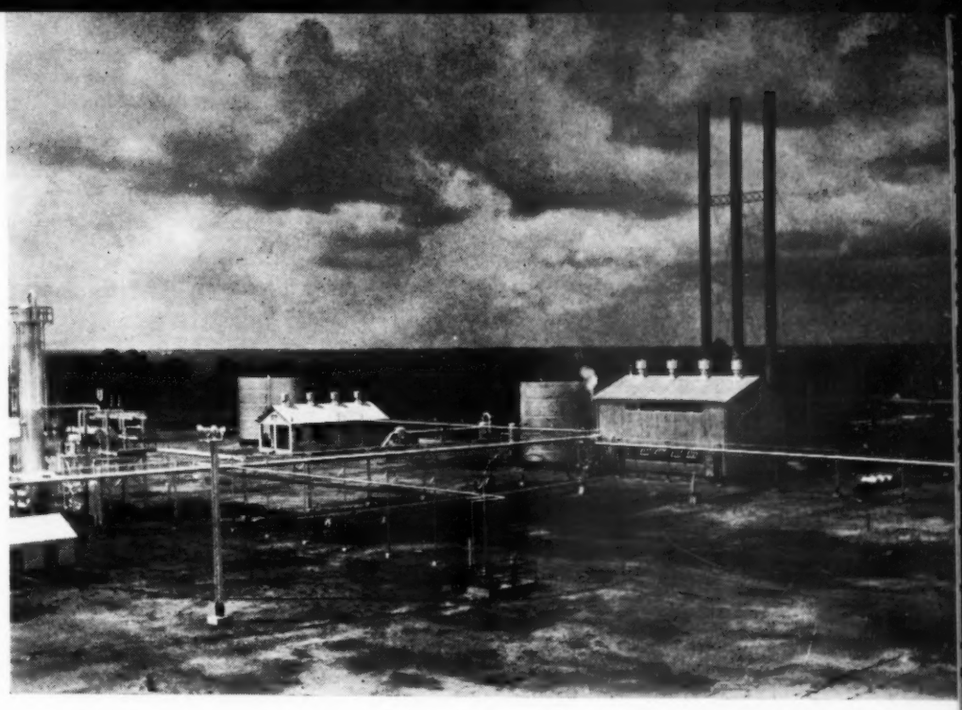
Residue gas from each absorber is scrubbed by a gas scrubber 42 in. in diameter by 8 ft. high, baffled to provide efficient gas/oil separation before the gas is allowed to enter the residue distribution system. The absorber outlet gas scrubbers are operated at a maximum working pressure of 840 lb. per sq. in., are stress relieved, and X-rayed for defects.



Two vacuum wet gas intake scrubbers, pulsation scrubber, and two 12-in. wet gas metering stations



Flow diagram of Tomball gasoline plant of Humble Oil and Refining Company



General view of boiler house and laboratory building

Two regulators are provided to hold back-pressure on the absorbers and each is capable of handling full capacity if for any reason the other should go out of service; and as a further precaution a regulator system has been installed that comes into action when the pressure reaches 15 lb. above the set operating pressure of the absorbers and pops the excess gas to the flare line.

The enriched oil from the absorbers enters a 13-ft. by 48-in. primary flash tower containing four plates, where the oil is flashed from 840 lb. to 300 lb. per sq. in. gauge. Residue gas from the primary flash tower goes to the plant fuel system. The maximum working pressure of the primary flash tower is 300 lb. per sq. in. gauge. Upon leaving the primary flash tower the oil enters a 12-ft. by 48-in. secondary flash tower where it is flashed from 300 lb. to 40 lb. per sq. in. gauge. The maximum working pressure of this tower is 60 lb. per sq. in. gauge. Gas from the secondary flash tower is sent to the reabsorbers, and the oil enters the suction of the rich oil pumps. The latter consist of one 2-in., single-stage, centrifugal pump and one spare. They have water-cooled packing glands, ball bearings, are oil-lubricated, and are driven by 60-hp. steam turbines operating at 3300 revolutions per minute. The oil is discharged to three oil-to-oil heat exchangers that have approximately 4000 sq. ft. of surface, then passes through two rich-oil steam preheaters having an approximate surface of 1600 sq. feet. From the preheaters the oil enters a combination still and rectifier.

The latter unit is approximately 54 ft. in height and of 60-in. diameter and has a maximum working pressure of 100 lb. per sq. in. gauge. It has 22 active bubble plates and integral all-water separators. Three side-stream draw-offs are provided in the upper section. In designing the still ample capacity was allowed and in this manner the need for an oil surge tank was eliminated.

Vapors from the still pass through two still condensers that have approximately 3200 sq. ft. of surface, the condensate going to a still reflux accumulator. The accumulator is a 4-ft. by 8-ft. vessel and its internal construction is such as to assure gasoline-water separation. Maximum working pressure is 100 lb. per sq. in. gauge.

Residue from the still reflux accumulator is sent to the reabsorber. The condensate is handled by a single-stage centrifugal pump driven by a 10-hp. steam turbine. Another pump of the same size and type serves as a standby. The total condensate from the still accumulator is handled by these pumps, and the reflux not needed to hold top temperature on the rectifier is sent to storage. Provisions have been made whereby side cuts can be taken off the three trays in the still, in this manner controlling the heavy ends going overhead.

Denuded oil from the stills enters three oil-to-oil exchangers and two lean-oil water coolers. Each of the latter has a surface of approximately 2600 sq. feet.

Uncondensed vapors from the still accumulator, flashed vapors from the secondary flash tank, and vapors from storage tanks enter a 45-ft. by 30-in. dia. reabsorber having 20 active bubble plates and a mist extractor in its top section. Maximum working pressure is 60 lb. per sq. in. gauge. Residue gas from the reabsorber is used in the plant fuel system and the enriched oil from the reabsorber is combined with the oil from the secondary flash tank at the suction of the rich oil pump.

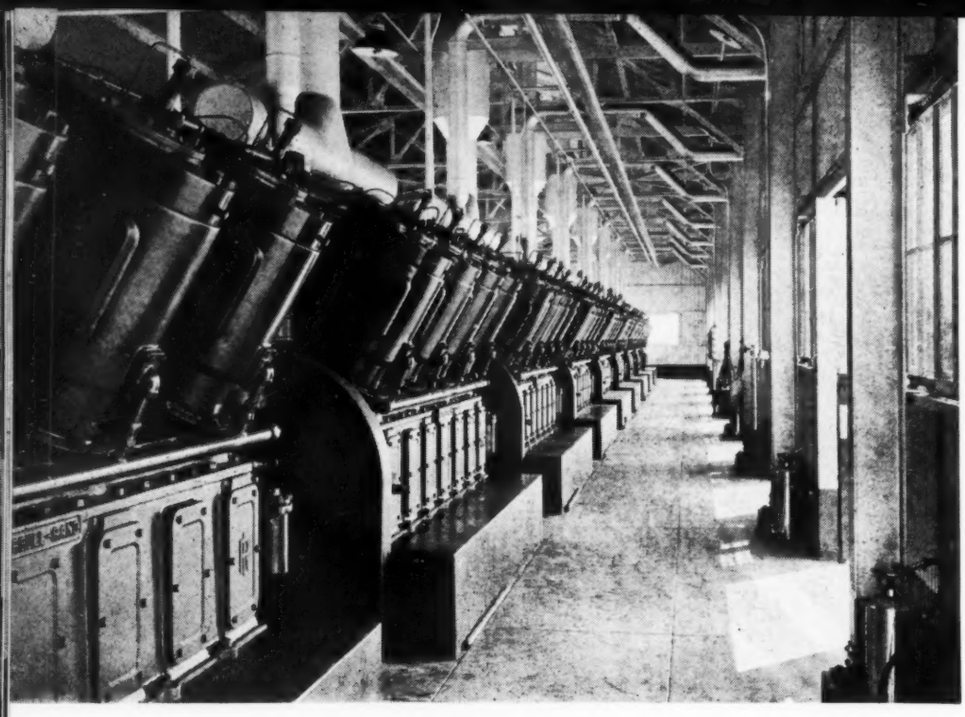
Lean oil is pumped from the lean-oil coolers by steam-turbine driven 6-stage centrifugal pumps. Two of the pumps are operated in series to raise the pressure from approximately 50 lb. per sq. in. gauge positive suction to 850 lb. per sq. in. gauge discharge. A third pump acts as a standby. All three are manifolded so that any two may be operated in series. The steam turbines driving the pumps develop 110 hp. each at 3300 r. p. m., and are equipped with hand speed changers that make it possible to vary the speed to meet any operating conditions that may be encountered. The pumps have mechanical seal packing.

All welded vessels in the distillation system were stress-relieved and built in strict accordance with the A. P. I.-A. S. M. E. code and so stamped. Valves and fittings in hydrocarbon service are made entirely of steel. Relief valves are installed in duplicate, each being capable of handling the demand without the aid of the other. This precaution was taken to allow an added measure of safety.

A central instrument board for controlling the equipment in the distillation system is situated in the distillation pump house. The following controls and instruments are on this board: top temperature controller for combination still and rectifier; controller for lean oil to main absorbers; two back-pressure controllers on the main absorbers; lean oil to reabsorber controller; still accumulator back-pressure controller; steam to still volume recorder; rich-oil preheater temperature recorder; recorder for total volume of gas to the reabsorber; two temperature recorders on gas to the main absorbers, and a pressure-recorder that indicates the pressure on the main line transmission system.

The plant obtains its water from a water well situated near the boiler house. The well is flowed by gas-lift (residue gas from the primary flash tower being used for the purpose) into a 30-ft. by 30-ft. welded tank from which make-up water for the plant is obtained. Automatic float control valves are placed in the cooling tower and the hot-well to control make-up water in the system.

The cooling tower is 230 ft. long and approximately 35 ft. high. It has capacity for cooling at the rate of 2100 gal. of water per minute from a temperature of 119 deg. fahr. to 85 deg. fahr. with zero mile wind and wet bulb of 80 degrees. The basin of the tower has been divided and the valves so arranged that for purposes



Power side of compressor units

TABLE I
Operating Pressures and Temperatures

Pressures:	
Main absorber	840 lb.
Primary flash	300 lb.
Secondary flash	42 lb.
Reabsorber	40 lb.
Still	100 lb.
Stock tank	95 lb.
Temperatures:	
Lean oil to absorbers	95 deg. fahr.
Rich oil to still	380 deg. fahr.
Lean oil from still	360 deg. fahr.
Still-rectifier top temperature	230 deg. fahr.
Still accumulator	90 deg. fahr.
Gas to the absorbers	90 deg. fahr.

of cleaning it of moss or other foreign matter water can be diverted to either side. Thus it is never necessary to shut down the tower while cleaning. To separate the two compartments of the basin conventional irrigation gates are employed.

Pumps on the water system consist of three single-stage centrifugal pumps driven by 85-hp. steam turbines. One pump handles hot water from the hot well, one pumps cold water from the cooling tower, and the third acts as a standby.

Water is circulated from the base of the cooling tower to the cold water pump. The cold water pump discharges through the gas coolers, oil coolers, and condensers into a 30-ft. by 30-ft. welded vertical water tank, the inside of which was specially treated against corrosion. The approximate volume handled by the cold water pump is 2100 gal. per minute. Water gravitates from the 30-ft. by 30-ft. tank to the engines and compressors, cooling them, thence to the hot-well situated near the pump house. In addition approximately 1000 gal. of water per minute overflow from the 30-ft. by 30-ft. tank to the same hot-well, by-passing the compressor units. The amount of water by-passing the compressor units varies. The arrangement is such that a fixed volume of water (2100 gal. per minute) flows through the system. Under ordinary conditions 1100 gal. per minute are required to cool the compressor units. As the volume required for this purpose varies the volume flowing directly into the hot-well and by-passing the compressors also varies. The water is picked up from the hot-well and discharged over the cooling tower.

For generating steam there are three 240-hp. water-tube boilers ample for 200-percent rating. Steam pressure of the boilers is 200 lb. per sq. in. gauge. Water and fuel regulators are a part of the boilers' equipment. Each boiler has a pilot light, placed in the firebox, for lighting the burners. At four strategic points in the plant yard emergency valves have been placed. With these it is possible to shut off the supply of fuel gas to the boilers and introduce live steam into the fire boxes. The main header from the boiler house is equipped with an orifice fitting and meter for measuring the steam. Boiler-feed pumps consist of one 2-stage centrifugal unit driven by a steam turbine, and one simplex pump, the latter a standby.

An exhaust steam condensing plant has been provided that results in very little make-up water for the boilers being required. The plant is designed to condense approximately 19000 lb. of steam an hour at three lb. per sq. in. gauge. Equipment consists of four atmospheric cooling sections connected in two parallel stacks of two each, and a tower 36 ft. long by 27 ft. high capable of cooling 760 gal. of water per minute from 150 deg. fahr. to 100 deg. fahrenheit. The atmospheric cooling sections are submerged in a condenser box.

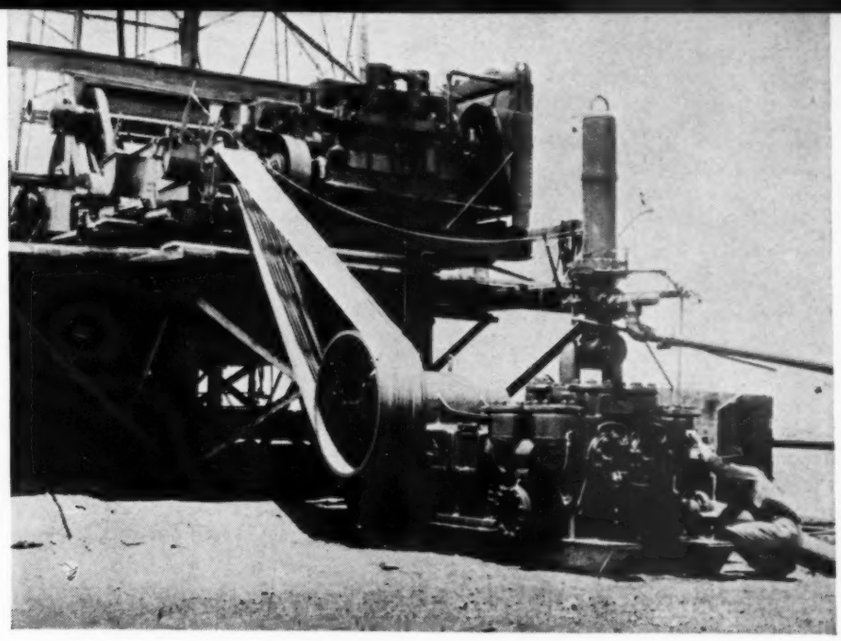
Tanks for storage of the finished product consist of ten 10-ft. by 40-ft. horizontal vessels having 125-lb. working pressure, four 8-ft. by 28-ft. tanks having 35-lb. working pressure, and two 500-bbl. bolted storage tanks.

Oil used for absorption is of 41 gravity, 170 molecular weight. The rate of circulation to the main absorber is approximately 12 gal. per M cu. feet. A steam re-run still has been provided for removing impurities from this oil.

A very efficient laboratory has been provided, housed in a separate building at one end of the grounds. Its equipment is complete for plant control work and for making field gas surveys. Two automatically-controlled fractionating units are provided for running hydrocarbon analyses, as well as the other equipment necessary for plant and field service for natural gas and natural gasoline.

In connection with the operation of the plant it is noteworthy that from the very beginning no difficulties have been experienced. While this is attributable, of course, in great measure to the design of the plant and the equipment selected, special training of the operating personnel prior to the opening should be given an ample share of the credit. The training course was very thorough, and in many respects was unusual in the manner in which it was conducted. Three months before completion of the plant each operator was given a booklet containing a complete description of each piece of equipment and its operation. These instructions were written by the manufacturers themselves. In addition repsentatives of the various manufacturers visited the plant at specified times and instructed the men. Each man was required to be familiar with every operating phase of the plant; in fact, not until after the course of instruction was completed did the men know in what part of the plant they were to work.

The plant was constructed under contract by the Fluor Corporation.



Two 200-hp. Cummins Diesel engines driving Wilson Titan modern mechanical rotary drilling rig in West Texas. The V-belt drive to 7¼ by 14 slush pumps is shown in foreground

By ORVILLE ADAMS

Diesel-Powered Drilling Rigs in West Texas

Recent developments and the economy of drilling operations as gleaned from the experience of a prominent drilling contractor in West Texas

SPECIALLY-DESIGNED Diesel drilling rigs placed in service in the West Texas Texas Permian Basin during the last two years have drilled hundreds of wells. As a result experience and records relating to economy and satisfactory operation have been accumulated. Typical of the results obtained from drilling operations with Diesel-powered rigs in West Texas is the experience of George L. Livermore, of Kermit, Texas, who owns four rotary and two cable-tool rigs, driven by 11 Cummins Diesel engines.

When the possibility of utilizing the Diesel engine for drilling purposes was first conceived it was evident that one of special design would be needed to cope with the severe requirements of oil-well drilling conditions to meet the demand for speed, torque, flexibility, and reliability. The need for such an engine particularly was apparent for drilling in areas such as the Permian Basin where many of the wildcat wells are so isolated that fuel and water can be had only at great cost.

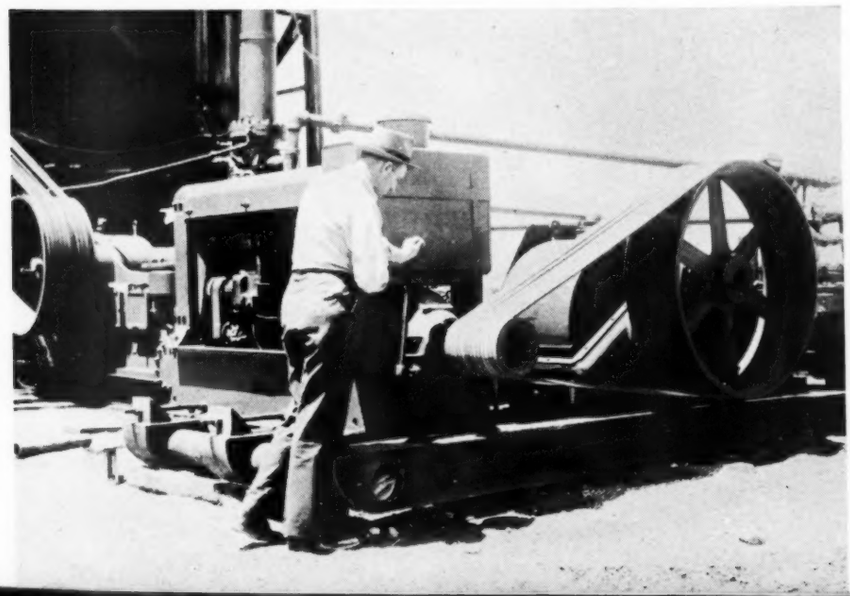
The development of a suitable clutch and transmission that will stand up under the Diesel drive is one of the factors that has made the Diesel-powered rig a success.

Recent Developments

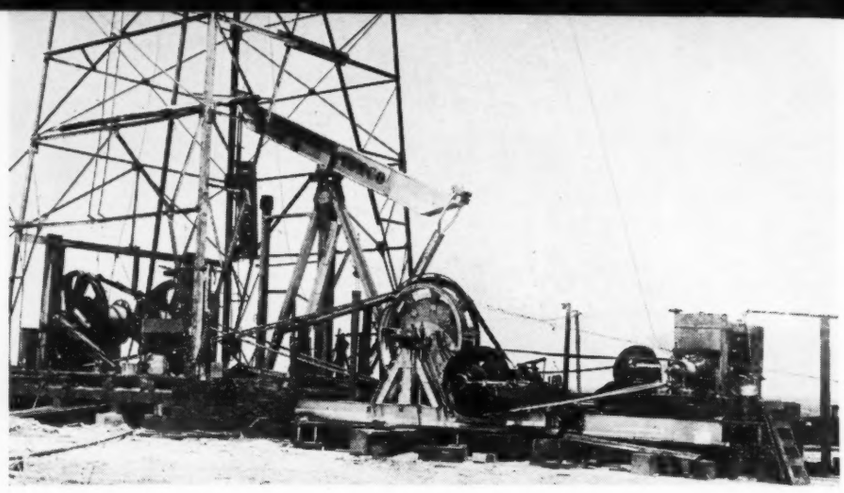
The correct application of Diesel power to the drilling rig was not made without overcoming problems of considerable magnitude. The size and weight of the Diesel engine were among the drawbacks to its early use for drilling. The heavy, bulky engine was objectionable and only in the last two or three years has this problem been solved with any degree of success. Manufacturers eventually succeeded in eliminating the difficulties associated with the heavier engines, such as slow speed, heavy concrete foundations, and the time required to rig up, as well as other difficulties encountered in obtaining reliable operation at idling speed, pick-up, and the like.

One of the most desirable features in any Diesel engine, and which at one time was lacking, is the ability to throttle, take on heavy loads, and then pick-up power and speed with the load from an idling start. Cold-starting under severe weather conditions also is essential. The successful type Diesel engine now used possesses all these qualities. Gear ratio in the transmission insures flexibility, and the greater the number of speeds from the transmission the greater the flexibility. The Diesel-driven rig, the engine of which has the ability to throttle under load, results in the saving of wear on all the equipment and in smooth, uniform operation.

Most of the modern Diesels em-



A 5 by 10 pump driven by 100-hp. Cummins Diesel used for mixing mud for rotary drilling in West Texas



Portable cable-tool rig being used to drill-in rotary-drilled hole below 4000 ft. in Ector County, West Texas. The rig is driven by a 100-hp. Cummins Diesel engine

ployed in drilling have suitable hoisting speeds. From a drilling standpoint, the modern Diesel applies a steady and uniform flow of power, both to the rotary table and the pump, and this insures straight hole and fast drilling.

Some operators prefer using two engines of the same hp., which can be compounded, power being delivered through a chain transmission. The compounding is of such arrangement that both engines may be hooked-on to the drawworks at the same time; or both engines on the slush pump; or both on the slush pump and the drawworks; or either engine may drive both slush pump and drawworks. The size of the slush pump determines the size of the engines to be used with the rig. The size of the engines should be such that one engine can handle the load of the slush pump.

Thus the gear ratio of the chain transmission is determined, so that at maximum drilling depth for which the drawworks is designed, one engine still has sufficient power to pull the drill pipe out of the hole. Under normal operating conditions one engine drives the rotary table and the other the power pump. With the two-engine hook-up, one engine is capable of handling the entire load at any time without shutting down the rig. In this way a standby unit is always available in case of emergency. With two engines for hoisting twice the hp. is available, which results in more speed on trips.

From the transmission to the drawworks are two drives, one in low gear, which drives into the face of the drum and has three speeds through the transmission; the other drive in high gear is to the friction clutch on the drum shaft. It also has three speeds from the transmission, which gives a total of six speeds forward on the drum. This number of speeds from the transmission insures flexibility and the result is not only power but also speed.

In assembling the rig, the drawworks is mounted on 10-in. H-beams 19 ft. long. Two engines are connected and placed behind the transmission on the 10-in. H-beams, and in this way, in moving from one location to another, the drawworks, transmission, and H-beams make one load and the two engines another.

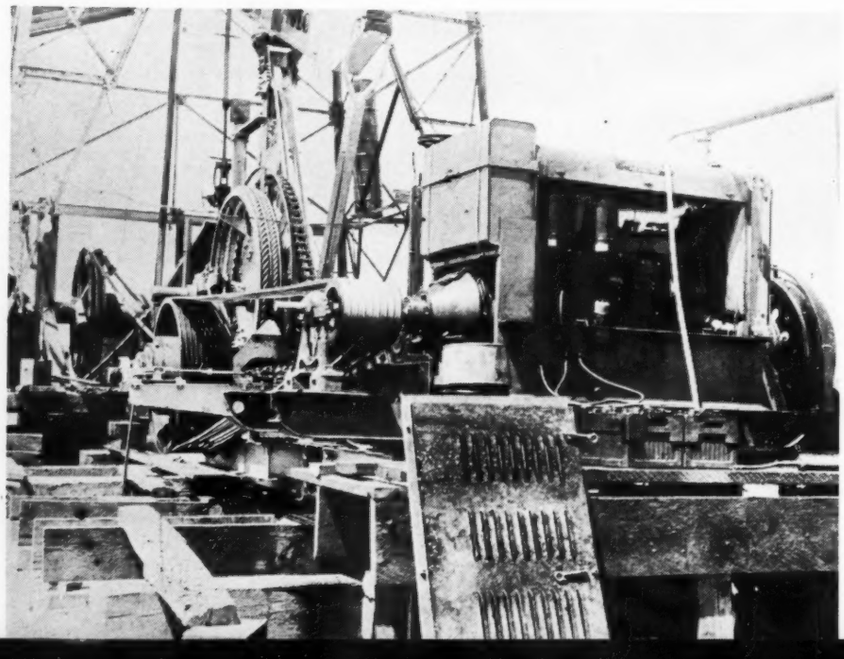
After the engines are assembled behind the transmission on the rig floor the combined unit is skidded on to a sub-structure, and the engines, transmission, and drawworks always remain on floor level. The drive to the slush pump is a multiple V-belt drive from the rear engine, allowing the slush pump to remain on the ground, whether the drawworks is on a steel sub-structure or mound. It is desirable always to have the slush pump as low as possible to obtain the greatest amount of fluid efficiency. It requires only two or three hours to set engines, pump, and drawworks after the rig arrives at the location.

Economy of Operations

As an example of economy and time-saving on the drilling location, the record of one Diesel-powered outfit, a Wilson Giant rotary mechanical rig with chain transmission and powered by two 200-hp. Cummins Diesel engines, is of interest. The average fuel consumption is between 160 and 200 gal. per 24 hours when drilling wells to a depth of 4000 feet. On such an operation it usually is possible to get on and off a location within 30 days, assuming a net drilling time of 20 days. During the last year and a half this rig has been in continuous operation, and the average fuel consumption has been about one and one-half gal. to the foot of hole drilled; roughly the fuel cost is $300 per well, assuming fuel cost at six cents a gallon. The average cost is between $10 and $12 a day for fuel and $5 to $6 a day for lubricating oil, and in no instance has the cost of fuel and lubricating oil for the rig exceeded $18 a day.

Reliability and flexibility of the engines on drilling operations count for a great deal more than the fuel cost, however. Satisfactory maintenance and upkeep cost and continuous operation once the rig is on location are of paramount importance. In this respect the rig mentioned has the record of having drilled 15 wells. In regard to maintenance and down-time, not so much as one hour drilling time was lost on the 15 wells as a result of engine trouble. There has been no overhaul and the maintenance work has been practically nil; the only repair job was the grinding of valves on one of the engines.

For information in preparing this article the writer is indebted to George P. Livermore, formerly district engineer and supervisor with The Texas Company, and now president of George P. Livermore, Inc., drilling contractors, Kermit, Texas.



Another view showing the 8-string V-belt drive on portable cable-tool rig driven by Diesel engine in West Texas

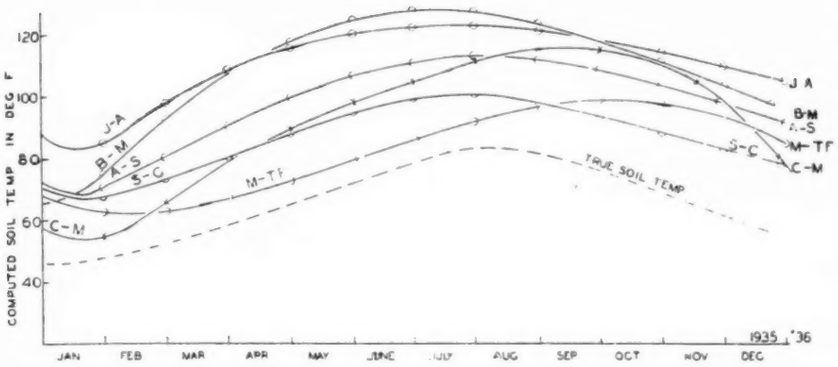


Fig. 1—Curves plotted from large number of computed soil temperatures for various sections of line (identified by letters such as s-c) from data obtained in dispatcher's record throughout year. Markers on curves drawn are not plotted points but are for identification purposes.

By
C. N. JOHNSTON*

Heat Conductivity of Soil Governs Heat Losses From Heated Oil Lines

THIS article is a resumé of a much longer discussion[1] in which it was shown that the heat conductivity of soils being traversed by hot oil lines governed the heat loss from those lines. Corrections to existing empirical formulas are provided to take into account the varying heat conductivity of the soils traversed.

The results of the present discussion are available after the investigation of operation records and soil characteristics from five sections of operating line. A study was made on the heated 8-in. oil line of The Producers Pipe Line Company† laid between Bakersfield and San Luis Obispo across central California. The five sections selected traverse varied soils. From Bakersfield to San Luis Obispo the line passes through desert to coastal weather conditions. The sections selected include both conditions. The pipe itself is laid from 18 in. to two ft. below the surface of the soil, depending somewhat upon the right-of-way requirements.

The pipe line dispatcher's sheets supplied an hourly record of pertinent operation data. The soils traversed were taken by sample from the field and were studied in the laboratory.

The dispatcher's record provides bbl. per hour pumped, gravity of oil, temperature into and out of the section (maximum temperature in 150 deg. fahr.). All records used were selected where conditions for the section were consistent or very nearly so; that is, the conditions had been constant for a few hours previously, the swing pipes were up (whenever possible), the type of oil being pumped had not been changed recently, and oil temperatures had not been varied. All data selected were taken when the flow was at or close to 1000 bbl. an hour.

Heat loss is a determining factor in pipe line design. It has been obvious from the beginning that heat loss has been influenced by prevailing weather conditions—both temperature and rainfall—yet even under ideal summer conditions, comparable sections of pipe line show wide differences in heat loss. Mr. Johnston's research gives the basis for determining in advance of construction, what actually will be the heat loss both in winter and summer over a given right-of-way.

From these data corresponding soil temperatures were computed for each of the hourly records for all the sections. Danforth's[2, 3] charts and formulas were used in this analysis. In addition, the temperature drop per 1000 ft. of line was determined for each section throughout the year. The results of these computations are plotted on Figs. 1 and 2. As may be expected, the computed soil-temperature graph is more or less a true reflection of the temperature-drop curves.

The point of interest in Fig. 2 is that among the various sections of line the temperature drop from summer to winter shows a marked divergence. Temperature drop being proportional in this case to heat loss, this variation in temperature drop indicates a proportional variation in heat loss among the several sections.

Such a variation is not a function

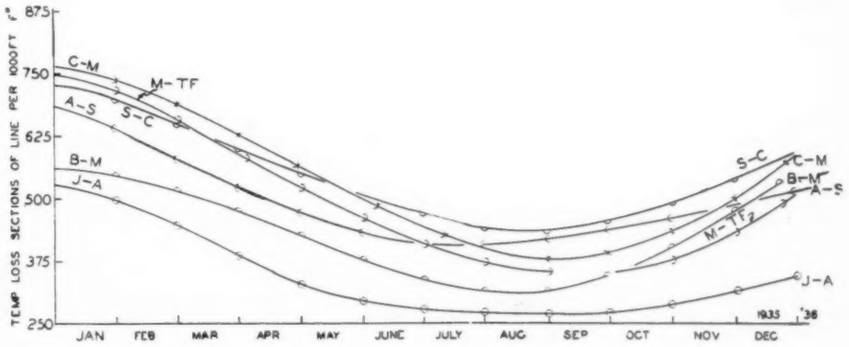


Fig. 2—Curves showing temperature loss for various sections of line. (Same identification as Fig. 1 to be used throughout remaining figures.) Temperature drop here proportional to heat loss because volume flow conditions constant. Note wide variations in heat loss between sections in summer and winter.

*Formerly with transportation department, Union Oil Company of California, now with the University of California at Davis.

†Thanks extended herewith to Mr. Lafe Todd, superintendent, Producers Pipe Line Company, for permission to study office records and pipe line sections.

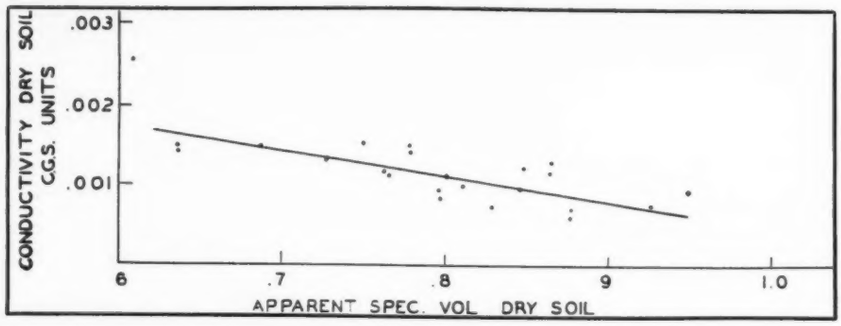


Fig. 3—This curve shows that the dry soils are better conductors of heat the lower the apparent specific volume (the higher the density). Each point indicates tests on separate soil.

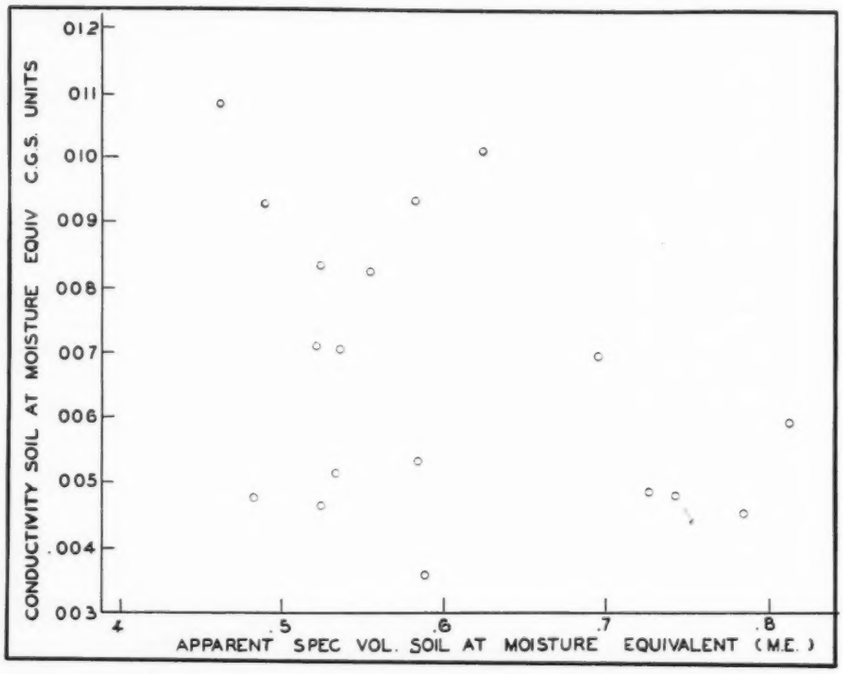


Fig. 4—When soils are wet to field capacity, or to the moisture equivalent, there is no relationship between soil heat conductivity and the apparent specific volume of the soil when wet to moisture capacity. Each point plotted represents test of separate soil sample.

of wetness of soils primarily, because in summer in California all soil about a heated oil line will be very dry beginning fairly early in the spring; yet in summer there is approximately a 100-percent variation in heat loss between sections (Fig. 2). Such divergence in heat losses suggests that the soil must vary in its ability to accept heat and must control the loss to a considerable extent.

The soils varied along the several sections investigated and it became necessary to study a number of samples for some of them.

Pipe line design must undertake the problem of achieving the most economical installation to meet the worst conditions. By worst conditions is meant not extreme operating conditions but those bad conditions that persist for relatively long periods. Conditions of extreme heat loss occur when water in quantity is passing by a heated oil line. Conditions of normal heat loss occur during the period the soil is still moist (at or near the field capacity) from previous precipitation.

It is well established that heat conductivity is a function of moisture content for any given soil. Soil heat conductivity is a difficult value to obtain. For this reason all the soil characteristics that can be measured more or less readily were studied to see if any would indicate by their magnitude the relative heat conductivity of the samples.

Those soil characteristics measured, in addition to the heat conductivity, were heat diffusivity, apparent specific volume (one over the density), apparent specific heat, moisture equivalent (field capacity), and the mechanical analysis. Soils were studied dry and also wet to field capacity.

The heat conductivity of a soil is best obtained by use of the method supplied by Patten[4]. His procedure involves the determination of the factors: apparent specific heat, apparent specific volume, and heat diffusivity. All these factors are affected by the moisture content of the soil. Patten's procedure is outlined briefly at the end of this article.

The moisture equivalent[5] is a close approximation of the field capacity. It is obtained in the laboratory by the

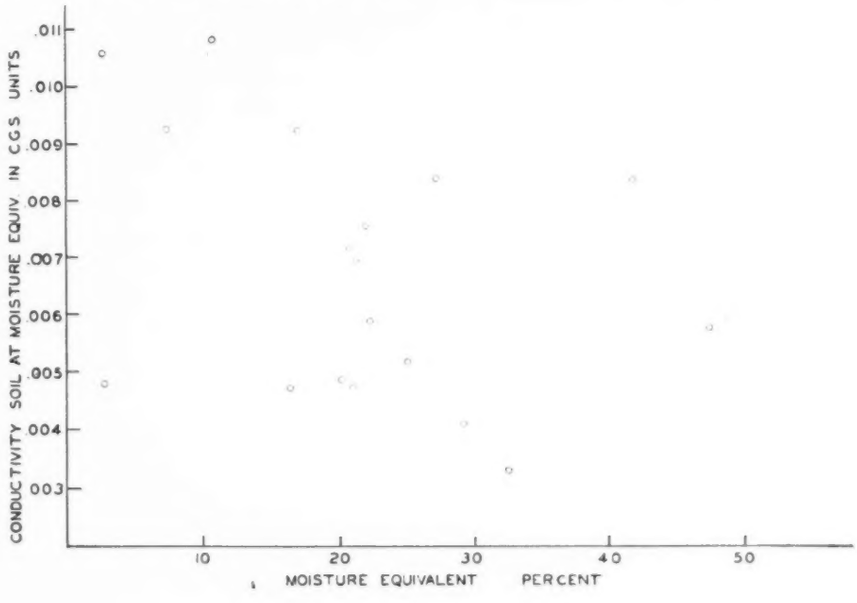


Fig. 5—The moisture equivalent bears no relationship to the heat conductivity of various soils. This is indicated by the dispersion of plotted results of tests on individual soil samples as portrayed above.

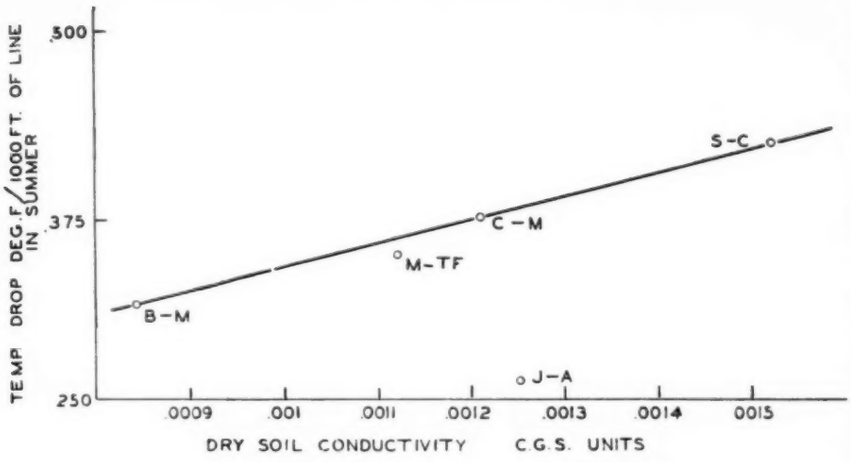


Fig. 6—The result of plotting, for the several pipeline sections, temperature drop per thousand feet of line (proportional here to heat loss also) against soil heat conductivity for summer, or dry soil, conditions.

use of the centrifuge. All soils have individual capacities to retain water in the field or against the centrifugal forces supplied by the centrifuge.

The mechanical analysis of a soil gives the distribution by particle size of the make-up of any sample under investigation. The measurement is made by a sedimentation process and is read as the percent of sand, silt, and clay in the sample.

Figs. 3, 4, 5 illustrate some of the results obtained by comparing some of these soil characteristics with the heat conductivity. All points plotted represent results from investigation of different soil samples.

Fig. 3 indicates that the denser the dry soil (the less the apparent specific volume) the greater the conductivity. This is logical because the greater the soil density the fewer the voids and, therefore, the better the particle to particle contact for the transmission of heat.

Fig. 4 shows that there is no relationship between soil conductivity and the apparent specific volume when the soil is wet to moisture equivalent. This condition of moisture content in soils most frequently will be the governing factor in design. Fig. 5 demonstrates that the field capacity or the moisture equivalent is no index of the heat conductivity.

The soil conductivity bore no relationship to any of the other soil characteristics studied.[1] The remaining graphs are not given here but Figs. 4 and 5 are typical of the others. It is unfortunate for the designer that the dry soil heat conductivity—apparent specific volume relationship established in Fig. 3—is not useful for design purposes. The designer must have information on the heat conductivity of the soils to be traversed when they are wet; no other soil characteristic studied will indicate the magnitude of that conductivity.

It has been shown that, although summer soils were all dry, the various sections of line investigated gave different temperature drops. It has been shown also that the soil heat conductivity differed for the various sections (Fig. 3). Fig. 6 portrays the result of plotting the temperature drop (proportional to heat loss) against soil conductivity for these sections. The writer felt justified in drawing the straight-line relationship shown although section J-A did not conform too well to the location selected. Two samples of soil were obtained for section J-A and the figure for heat conductivity plotted is an average of the two results obtained. It seems probable that the average is not accurate. Had the sample of least heat conductivity been used alone (it represents nearly 90 percent of the length of the line) the plotted point would fall almost on the curve drawn.

Fig. 7 shows that a straight-line relationship exists between wet soil heat conductivity and oil temperature drop for the several sections. This latter relationship is not so well defined as that for dry soils because the soils about the pipe lines were subject to various degrees of wetting and the soil samples were tested at the moisture equivalent. It is of importance to note that, although the relative magnitudes of heat loss shifted from summer to winter on the various sections, the relative conductivities also had changed by wetting from the rains. This retained the straight line relationship found. Here again section J-A does not conform to the drawn curve. The use of the sample representing the major portion of the line again would place plotted section J-A almost exactly on the curve.

These figures provide a method for adjusting Danforth's[2, 3] heat loss coefficient "K" to correct for soil type being traversed by the pipe line.

Inspection of Fig. 1 reveals that reasonably constant corrections of computed ground temperatures will cause any of the computed soil temperature curves to fit the true soil temperature curve. This is so because the computed soil temperature curves are roughly parallel to the true soil temperature curve. Fig. 8 shows the result of plotting necessary corrections to the computed soil temperatures against the cor-

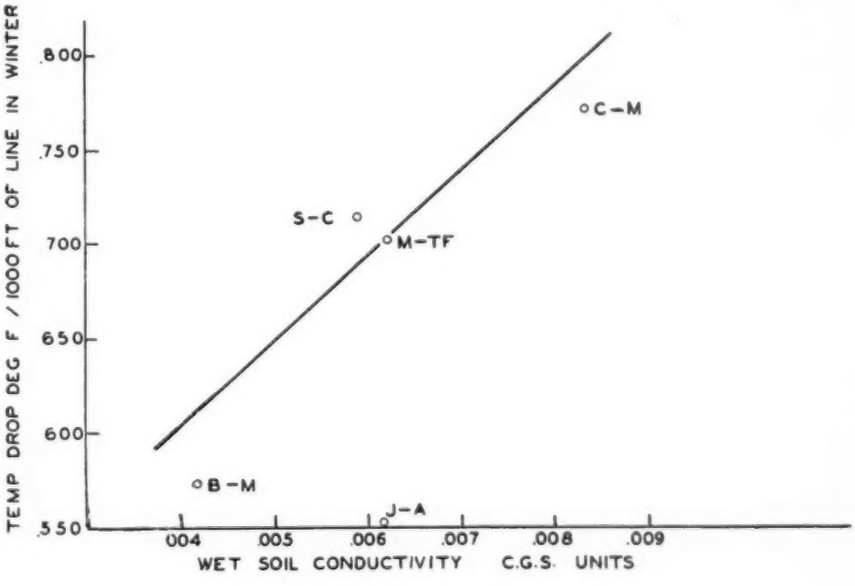


Fig. 7—Relationship, for several pipeline sections, between wet soil heat and temperature drop in the pipeline oil stream in winter. Variations of soil moisture from true soil moisture percentages for several sections of line probably account for partial dispersion of plotted data.

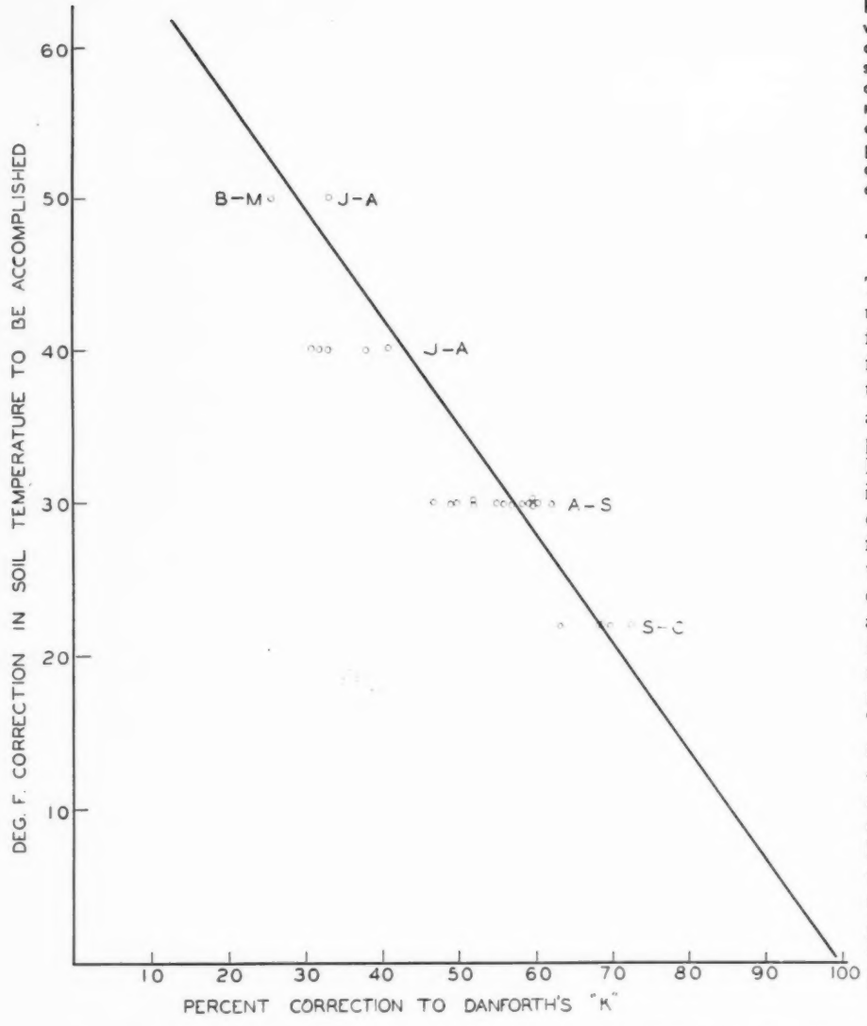


Fig. 8—This figure presents a curve from which it is possible to determine what portion of Danforth's heat transfer coefficient "K" should be used in order to effect a required correction in computed soil temperatures derived by use of the original "K" and pipeline operation data. Such a correction in computed soil temperatures is designed to produce computed temperatures coinciding accurately with true soil temperatures.

responding required percentage of Danforth's "K" that would bring this about. The plotted points were made available as follows:

Section S-C requires roughly a correction of 20 deg. fahr. in computed soil temperature. It is possible to compute what "K" value would achieve this correction. Such a "K", or heat transmission coefficient, is found to be a fairly consistent 70 percent of Danforth's "K". This process was repeated for a sufficient number and range of corrections to computed soil temperatures to locate the straight line as drawn on Fig. 8. This method may be pursued regardless of soil conductivity findings previously made for the sections.

The correction to "K" is not affected by the value of Danforth's turbulence factor "R".[1]

That a given soil conductivity affords a given heat loss in a line, other conditions being fixed, has been shown.

The reader also understands that the use of the present constant heat transfer coefficient "K" supplied by Danforth gives computed soil temperatures that will account for the heat loss in an operating line, but that these computed soil temperatures are in error. Further, we have found that the errors in computed soil temperatures may be corrected by use of a corresponding fraction of Danforth's "K". Therefore, we are justified in plotting soil heat conductivity for wet and dry soils against the correct percentage of Danforth's "K" to be used. Fig. 9 presents this relationship of soil heat conductivity and correct "K" percentage. These two curves, and particularly the right-hand one, supply the necessary data to assure accurate pipe-line design. It becomes necessary, in most cases, only to determine the wet soil heat conductivities for the right-of-way contemplated. Then the heat transfer coefficient may be adjusted to give design results that will conform very closely with conditions as found in field operation.

The apparatus necessary to determine the soil heat conductivity is described by Patten[4], but this publication is out of print. A short outline of his procedure is given herewith. Fig. 10 illustrates the general arrangement of the test equipment. Steam may be applied to the steam chest at any instant.

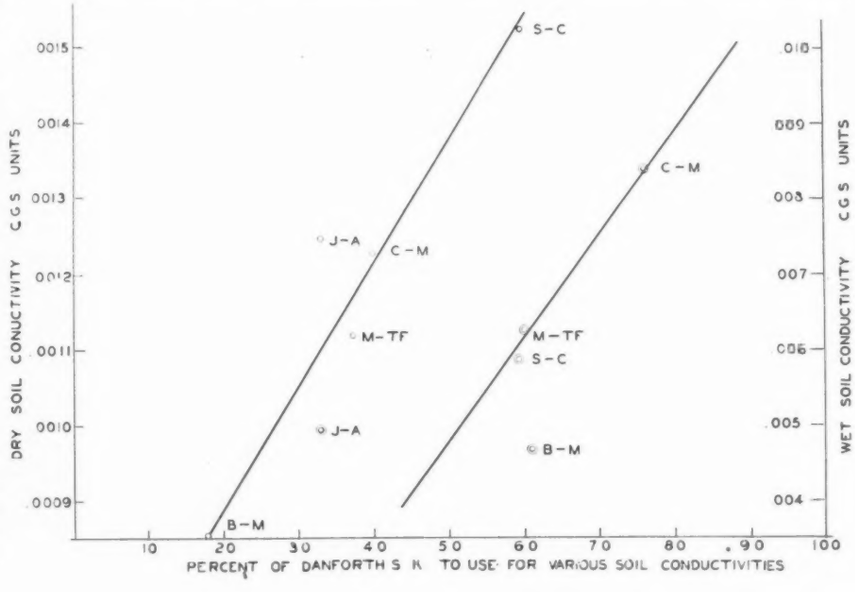


Fig. 9—Correction of Danforth's heat transfer coefficient "K" to use for dry soil (left-hand curve) and wet soil (right-hand curve) conditions. Use of these curves depends only on a knowledge of the soil heat conductivities, wet and dry. The right-hand curve will be used most because moist soil conditions represent worst operating conditions for which design must make provision.

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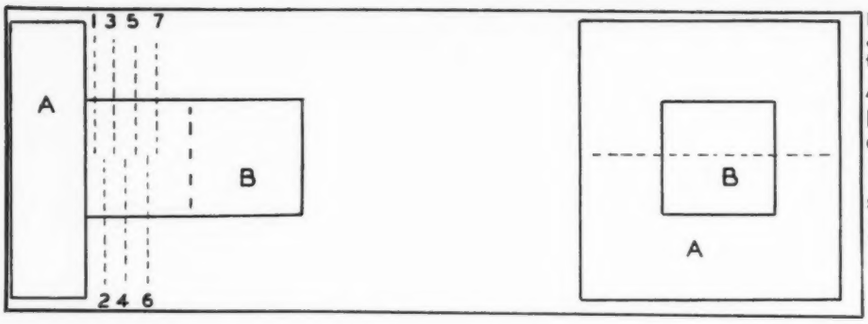


Fig. 10—General arrangement of soil box and steam chamber for soil heat conductivity tests.

A = Steam Chest
B = Soil box — 10 cm inside Cross-section
1-3-5-7 = Thermometers — 2 cm spacing
2-4-6 = Thermometers Midway 1-3-5-7

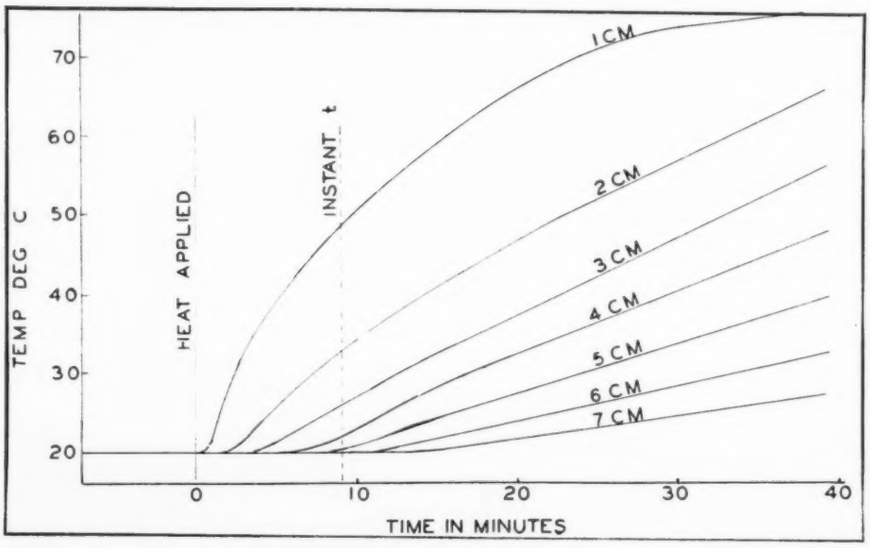


Fig. 11—Curves resulting from plotting temperature-time data obtained from thermometers in soil box during a soil heat conductivity test.

The heat wave then will start across the box, normal to the face of the chest. Plotting the time vs. temperature record for the thermometers, a graph such as on Fig. 11 results. This group of curves is typical of a dry soil. It is necessary to determine the correct instant for which we want the rate of change of temperature for thermometer 5, which we accept as sufficiently far from the heat source to avoid physical changes in the soil. This instant is found by plotting a carefully-kept record of time and temperature on thermometer 5 as obtained during the test run. Its record appears in Fig. 12. The point where the rising line first straightens upward is the desired instant (instant t). Returning to Fig. 11 we locate instant t as a vertical line intersecting the temperature time curves for the thermometers. From these intersections we can plot a curve, Fig. 13, which is a temperature gradient curve for instant t. The slope of the curve for thermometer 5 on Fig. 11 at instant t is $\frac{d\theta}{dt}=$ the rate of temperature rise with time. The slope of the curve at thermometer 5 on Fig. 13, $\frac{d\theta}{dx^2}$ = rate of change in temperature across the box.

$$\frac{d\theta}{dt} \div \frac{d^2\theta}{dx^2} = \text{diffusivity.}$$

The above two factors $\frac{d\theta}{dt}$ and $\frac{d^2\theta}{dx^2}$ are available after the procedure outlined has been completed. The soil heat conductivity factor K may be solved for in the formula: $K = c\left(\frac{d\theta}{dt}\right) \div \frac{d^2\theta}{dx^2}$ where c = the thermal capacity of the soil or its effective specific heat.

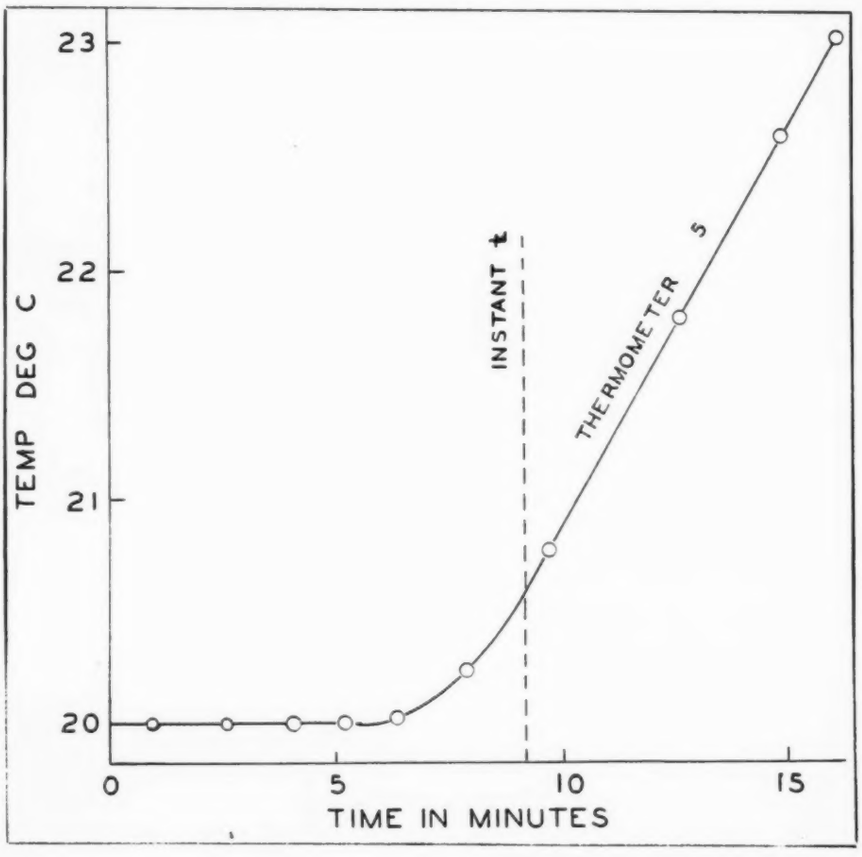


Fig. 12—Curve resulting from plotting detailed time-temperature data from thermometer 5 (5 cm. from heated face of steam chest) in order to determine "instant t" when accelerated temperature change just begins to plot as a straight line.

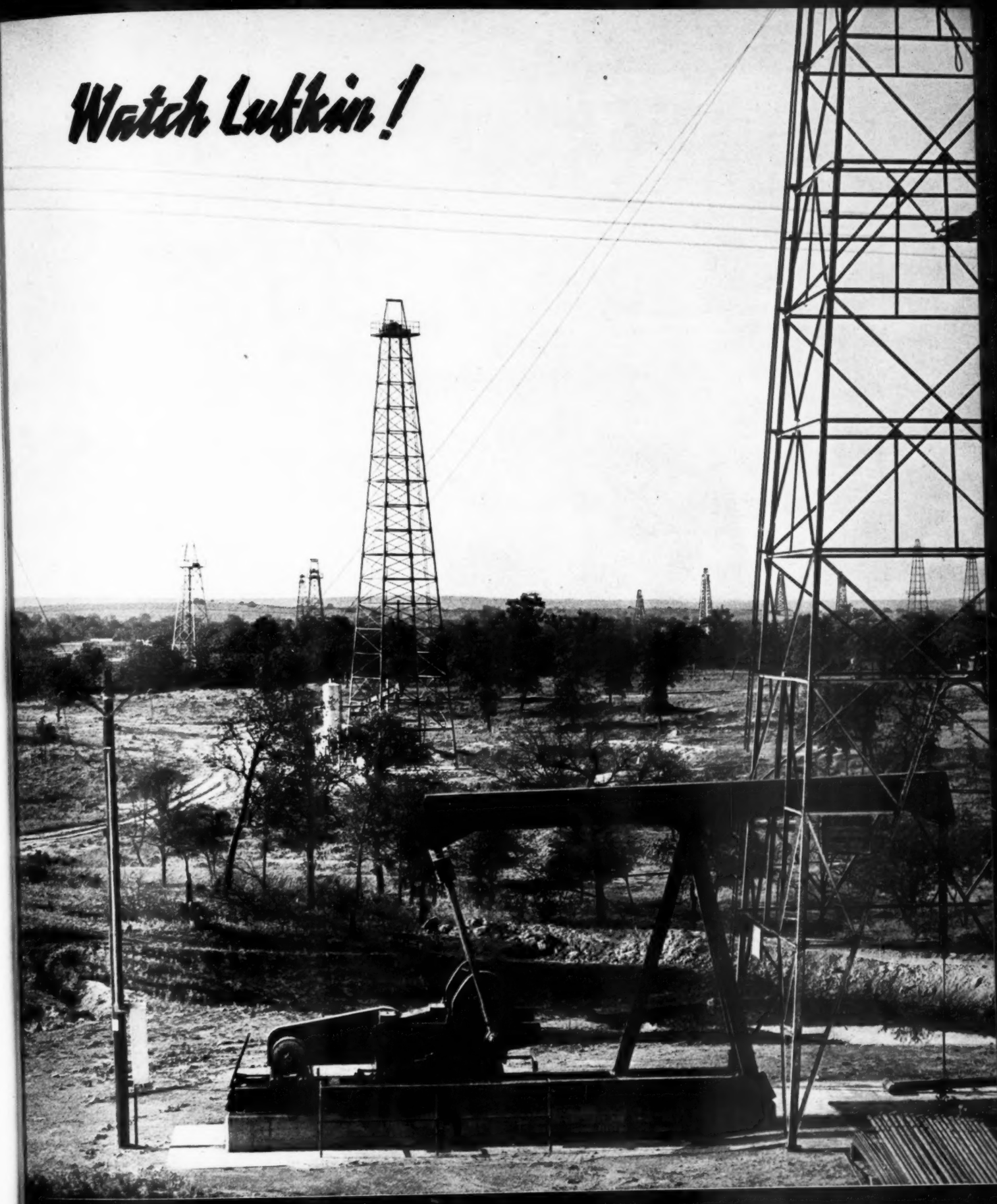
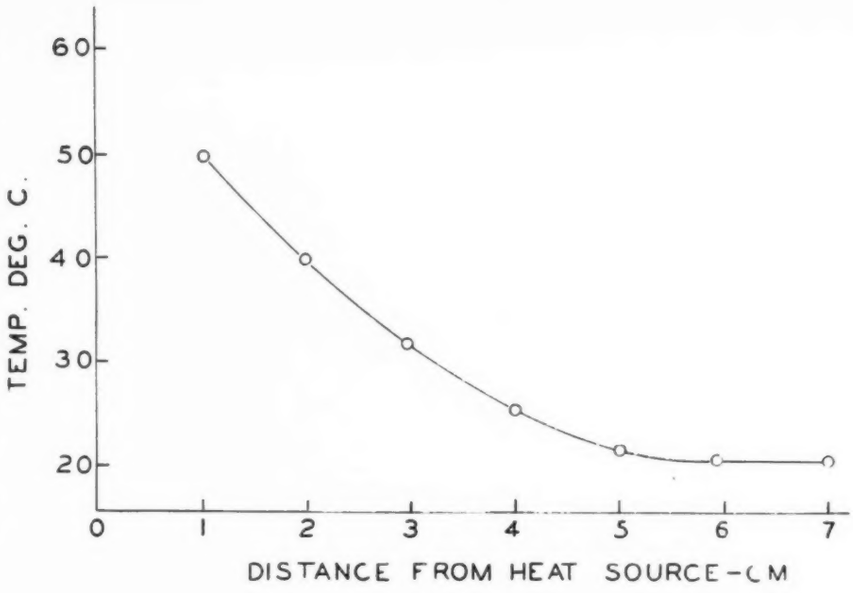

Watch Lufkin!

Fig. 13—Temperature change along the soil box at instant t as plotted from Fig. 11 using intersection points of thermometer curves with instant t line.



The effective specific heat is the specific heat of the dry soil plus the specific heat of the water it contained when being investigated. Trapped gas is neglected.

The specific heat of the dry sample is obtained by use of water colorimeter correcting the calculated specific heat by the measured heat of wetting for each sample.

All measurements are in CGS units in this procedure.

The data and calculations therefrom seem to tabulate best in the following order:

1. Sample identification
2. Apparent specific volume
3. Percent moisture on wet weight
4. Percent moisture on dry weight
5. Effective specific heat
6. $\frac{d\theta}{dt}$ = rate of change in temperature at designated thermometeral instant t
7. $\frac{d^2\theta}{dx^2}$ = rate of change in temperature along box at time t and at designated thermometer (No. 5 in this case)
8. $\frac{d\theta}{dt} \div \frac{d^2\theta}{dx^2}$ = diffusivity.
9. Calories per gm. of soil per minute = 5 ÷ 6.
10. Calories per cc. per minute = 9 ÷ 2.
11. Calories per cc. per second = 10 ÷ 6.
12. Calories per sq. cm. per sec. per deg. change in temperature gradient, or K = 11 ÷ 7.

Soil may be obtained at moisture equivalent or field capacity in the field by flooding a small area one day and removing a sample (20 to 30 lb.) in a moisture and air-tight container within the next day or two. If the container is tight the sample may be held for a reasonable period until tests are run. Care must be taken to pack the soil sample in the heat test box uniformly and to have the same packing for the apparent specific volume determination. As a factor of insurance a small closed sample of the larger body extracted should be weighed wet, dried and reweighed dry in order that the field capacity may be computed on the dry weight basis. Then if the main sample becomes uncovered and moisture is lost it can be returned to field capacity from the oven-dry state by the addition of a weighed amount of water that must be thoroughly mixed with the sample.

The proper application of data resulting from the procedure outlined should produce pipe lines whose design features will match operation characteristics more closely than has been possible in the past.

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2. Danforth, R. S. "Oil Flow in Pipe Lines." c. 1927.
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4. Patten, H. E. "Heat Transfer in Soils." U.S.D.A., Bur. of Soils, Bul. 59, 1909.
5. Veihmeyer, F. J., and A. H. Hendrickson. "Essentials of Irrigation and Cultivation of Orchards." Calif. Agr. Ext. Cir. 50:5, 6., 1930.

Arc-Welding Process Has Extended Its Field of Usefulness

TRUE to the predictions made for it a decade ago, the electric arc-welding process has been making tremendous strides in extending its fields of usefulness. The growth in volume in the past five years is clearly shown by the National Electrical Manufacturers Association's reports of electric welding wire consumption, from 18.8 millions of pounds in 1932 to 111 millions of pounds in 1936. That this progress is not all due to the general revival of industrial activity is shown by the steady increase in volume of consumption in the early 30s, before any real revival had started. A more graphic proof is the increasing amount of electrodes being used for each ingot ton of steel poured. In 1932 the figure was 1.4 lb. of electrode for each ingot ton; in 1936 this figure had reached 2.4 lb., an increase of 71 percent.

Activities in 1937 indicate that the trend is still definitely upward. Prominent naval engineers have stated that the riveted ship is on the way out, barge and tanker construction for inland waterways is largely an all-welded job, railroad freight cars are being welded in thousand lots, the petroleum industry is building larger pressure vessels whose service practically demands welded construction and approves the process for fabrication of all kinds of containers and piping systems, machinery from the smallest up to the most massive mill equipment is using welded structures to replace castings. These high spots are showing the way and establishing confidence in arc-welded structures. The old limitations have been nearly all swept away, some of them within just a few years.

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The Dehydration of Natural Gas

Brine Plants

PART 3

By
JAS. R. COWLES

ACTION of Brine. Brines of calcium chloride, at present the most outstanding of the liquid absorbents, are capable of removing water vapor from a gaseous mixture. By regulating the brine concentration and temperature this property affords a means of removing water vapor from natural gas by passing the brine and gas through a bubble tower simultaneously. The effect of temperature makes the process more feasible when the brine is cooled by a refrigerating agent such as butane, though under favorable conditions this is not necessary. A good example of this latter case is a climate such as that of Montana.[13] The properties of calcium chloride solutions are given graphically in Fig. 4[1].

Considering Fig. 4, the freezing point is the temperature at which crystallization sets in because of low temperature. The crystallization point is the temperature at which crystallization sets in because of high concentration. The dew-point line represents the dew-point the gas would attain, regardless of its initial condition, if it remained in contact with the brine until it comes into equilibrium with it. The several lines are necessary to take into account the effect of temperature.

In actual practice the dew-point is not reached, the lag being a function of the design of the bubble tower used. Obviously this lag and a safe margin from the crystallization points are matters of importance to the plant designer, and operator.

Freezing of the Brine. The freezing temperature perhaps is of the greatest importance in a plant, once the other necessary conditions are satisfied. With solutions as concentrated as those necessary, crystallization is not a gradual process, and the entire batch of brine quickly becomes an unusable slush. Such a condition puts a plant out of service until the brine can be "thawed out." The danger best can be realized when it is remembered that lower temperatures favor the best dehydration conditions, hence as close a margin as feasible is practiced.

The most practical method of combating this situation is temperature control, but this often proves inadequate. Tignor[8], among others, reports the addition of glycerine to the brine to be a practical solution of this difficulty. In his report Tignor suggests 50 percent by weight of glycerine. Solidification then does not occur, and the solution and suspension of calcium chloride has substantially the properties of a saturated water solution. Unfortunately there appears to be no data on plant scale use of such glycerine solutions. The idea has been patented for use with manufactured gas (U. S. 1,740,248).

In connection with freezing, an important feature of design appears. Though it is desired to keep the brine temperature as low as possible it is necessary to remove the absorbed water by heating a portion of the brine. This usually is done by allowing a portion of the brine to drip over steam coils. To keep the amount of heat added to a minimum the portion of the brine heated is raised to as high a temperature as possible. This engenders concentrations of the brine that will freeze readily upon cooling. To avoid this the evaporating coils are placed directly above a tank of the brine at normal plant concentration so that the heated brine has no chance to cool before it is diluted.

Corrosion Due to Brine. Calcium chloride is noted for its corrosive nature; however, most reports concerning brine plants state that corrosion is of reasonable magnitude. This clearly illustrates that such corrosion can be kept at a reasonable minimum by careful plant design. Hammerschmidt gives a critical summary of the situation.[1]

The Effect of Alkalinity. The higher the alkalinity of a brine the less corrosion will be encountered.[14] In the customary applications advantage of this is taken, but unfortunately the practice cannot be carried into dehydration plants. Due to minute quantities of carbon dioxide in the natural gas such agents are soon precipitated and the brine assumes a definite alkalinity.

Inhibitors. These agents have the peculiar property of reducing corrosion in many cases, such as are now being considered, without in general affecting other properties of a liquid. Again these are valueless in a dehydration plant because they are soon precipitated.

Dissimilar Metals in Contact.[9] A clear statement of the facts is important here. Certain combinations of metals are undesirable. On the other hand the second metal may protect the first as the zinc does in galvanized iron. It is entirely possible that it would be more desirable to have excessive destruction of an inserted valve seat than to have an entire piston head in a pump slowly corrode away. In making this statement the writer is in no way advocating here an attempt to check corrosion in this way, but to present a fact that helps in understanding dissimilar metal effects. Whether

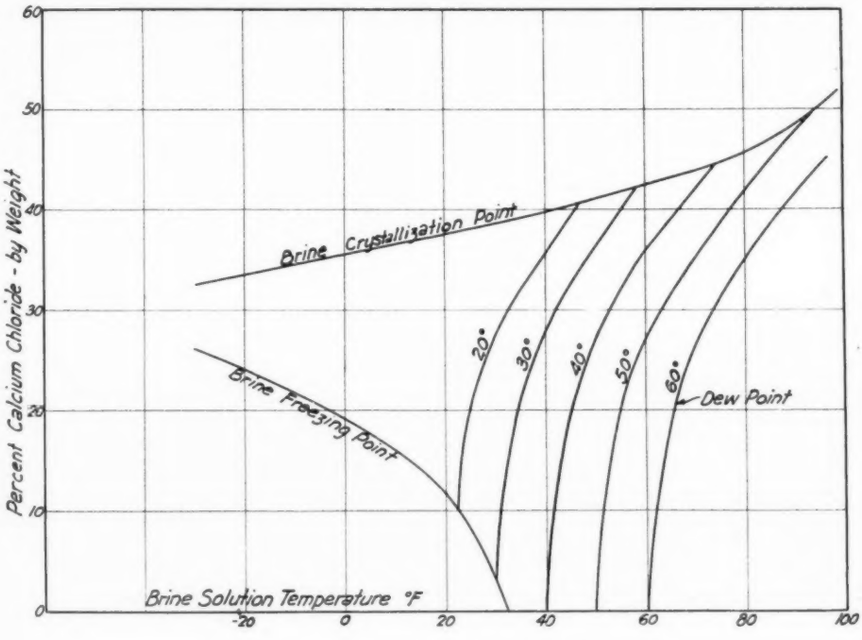
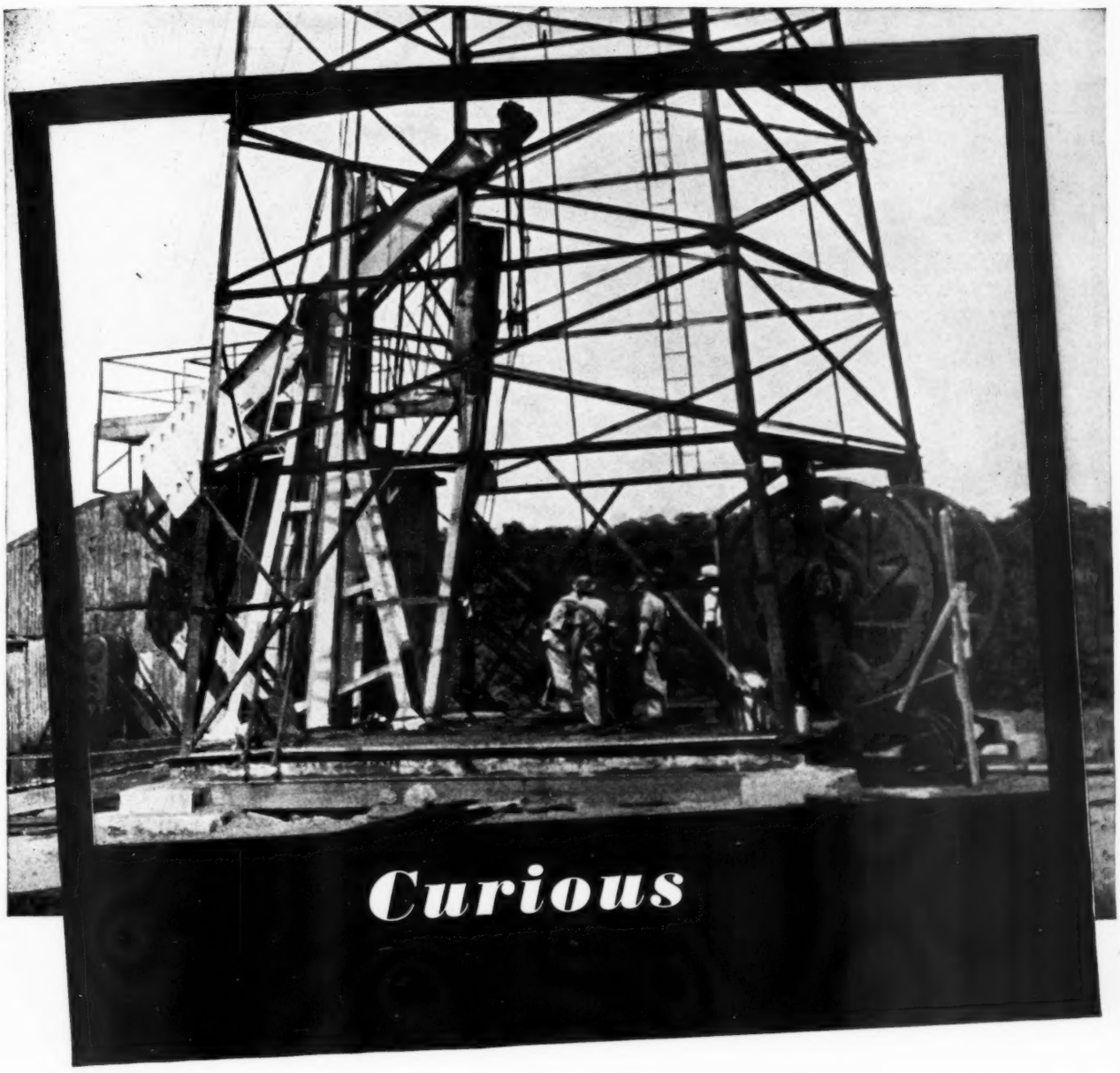


Fig. 4. Properties of calcium chloride brine



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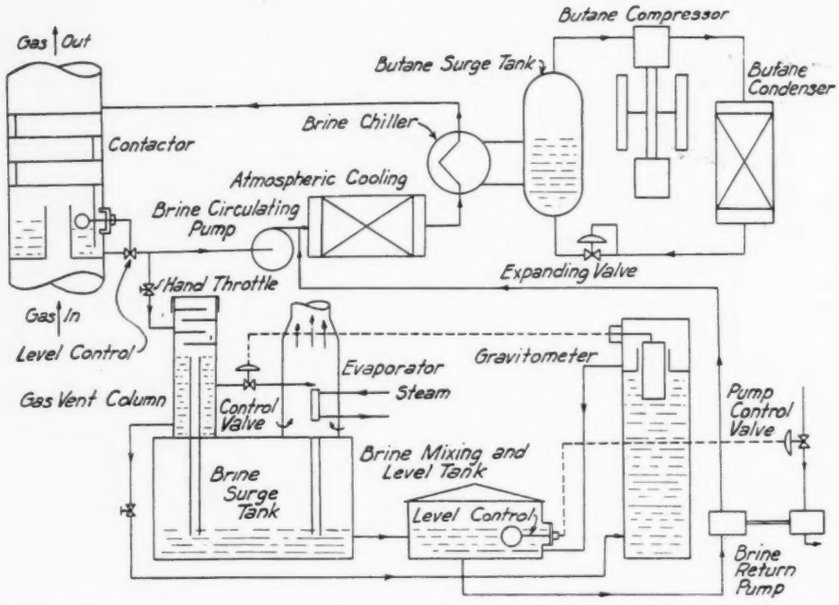

Fig. 5. Refrigerated brine dehydration plant

checking corrosion in this way is practical is a matter of study and experience. Again, this second metal may not increase the pounds of metal corroded away in a given time, but it will localize much sooner the corrosion around the junction causing failure. It is safe then to say that dissimilar metals should be avoided.

What constitute dissimilar metals is another important item. The apparent dissimilarity may be extremely small. Often the only thing that can account for severe corrosion is the almost unnoticeable flakes of mill scale left on iron products in their manufacture. In dehydration plants the usual report is corrosion of the cast-iron parts where most of the system is steel. Hammerschmidt mentions corrosion of pump rods and valves. In this case there is not only a probability of difference in metal, but also the fact that straining a metal sets up dissimilarity within the metal.

The way to minimize the losses due to dissimilar metals is a problem best solved by experience. The elimination of such obvious cases as brass and cast-iron may not be sufficient. In the case of the pump rods and valves an attempt is being made to lessen damage by using special alloys. If such proves successful it either may be due to a reduction of dissimilarity in metals or to transferring of losses to the larger body where they will be less consequential.

Effect of Air on Corrosion. Speller[9] discusses the general aspects of this in some detail. According to the electolytic theory of corrosion, which applies here, the oxygen dissolved in a liquid accounts for the most of the corrosion found. Such oxygen comes chiefly from the atmosphere where liquid can make direct contact. The destruction does not occur at the point of contact with such dissolved oxygen, however, but at points near which this dissolved oxygen comes but cannot reach. Thus in the case in point, contact of the brine with air is destructive to all parts of the system to which the fluid can travel before its supply of oxygen can be exhausted by the process of corrosion. Again this corroding effect is severe where there is a thin film of solution on metal or where drops of the fluid on metal are exposed to the air. In this case the effect is felt at the central portions of the surface under the drops. Thus severe corrosion of the evaporator tank is reported.[1] As the evaporator is the principal source of any oxygen to be found in the brine it is essential that air be excluded by the water vapor as much as is feasible.

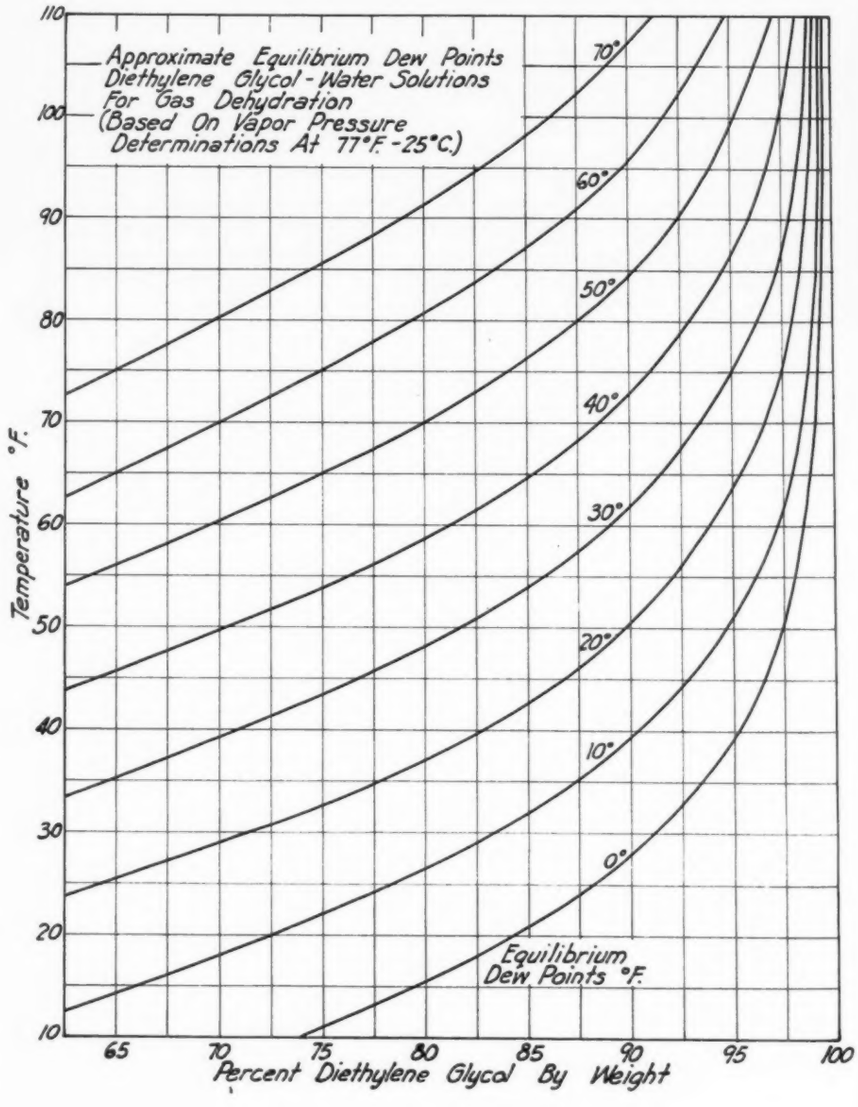

Fig. 6. *(Curve by courtesy Carbide and Carbon Chemicals Corporation)*

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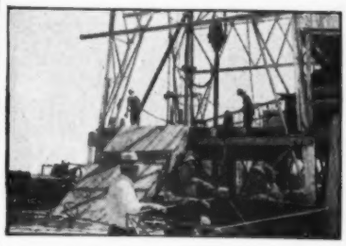

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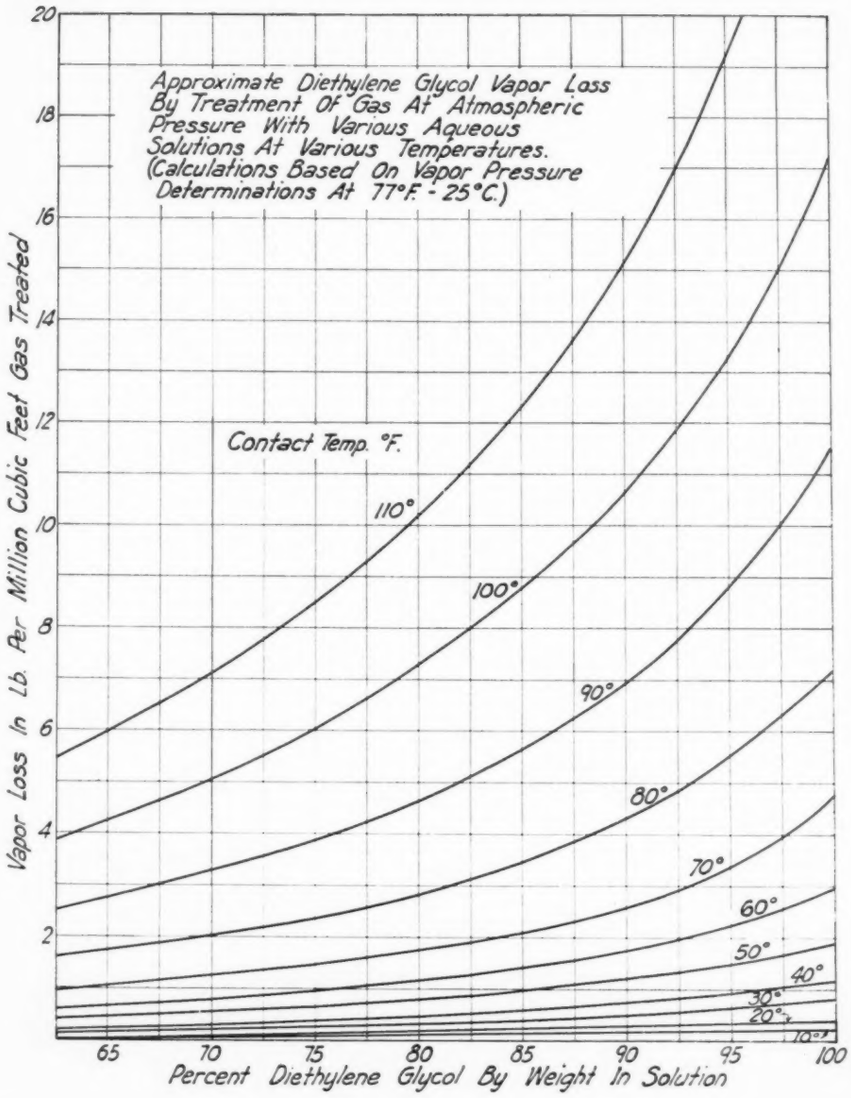

Fig. 7. *(Curve by courtesy Carbide and Carbon Chemicals Corporation)*

The foregoing is somewhat detailed, but since corrosion is perhaps the most undesirable feature of brine as an absorption medium it is only fair to show the limitations in this respect. Fear was expressed concerning the first plants that brine might be entrained in the outgoing gas and thus cause trouble. No such trouble has ever been reported, so it is safe to say that with the usual precautions no such difficulty is to be anticipated.

Straight Brine Absorption Plants. In this system the brine and the gas are brought into contact in a bubble tower. Without other regulation of the brine temperature than that afforded by the cooling water, sufficient water is removed from the gas. The beneficial effect of low temperature on the brine efficacy favors plants with refrigeration added more than those of the unrefrigerated type. A flow sheet of such unrefrigerated plants can be obtained from Fig. 5 by disregarding the refrigeration portion.

Refrigerated Brine Absorption Plants. The underlying principles have been covered in the various preceding discussions. Fig. 5[15] is a representative flow sheet. Contact between gas and brine is attained as in any other liquid absorption plant. The exhausted brine passes to a column where the dissolved natural gas is vented and from there the main body of the fluid flows into what is known as the brine surge tank. The remaining portion passes over heated coils, where a portion of its water content is removed, and then into the same tank. Next it passes to a mixing and leveling tank which acts as a reservoir. From this tank a portion is passed through a gravitometer, that automatically regulates the amount of water evaporated by controlling the portion passing over the evaporating coil. A pump then forces the warm brine through a preliminary atmospheric cooling tower, and through the butane (in this case) brine chiller. Circulation is aided by a second pump marked "Brine Circulation Pump." The refrigerating section of the plant is of the usual type and need not use butane specifically.

Liquid Absorption Plants

General. This heading has been reserved for systems using agents other than brine. Basically it is the same as straight brine absorption plants already mentioned. The various agents already have been described briefly. The method has the advantage of requiring no more than atmospheric cooling in the way of refrigeration. This follows from the definition adopted. Restricting the remainder of the discussion to diethylene glycol, it has the further advantage of capacity to produce dew-points that would tax a brine plant. In a recent test[16] a dew-point of 18 deg. fahr., which with calcium chloride solution would require conditions dangerously near solidification points (see Fig. 2), was obtained in a commercial plant. There is no danger of corrosion, nor solidification.

Plant Design. The plant in point consists of a bubble tower for a contactor, a stripping column for removing water from the diethylene glycol, an atmospheric cooling tower for refrigeration, and heat exchangers for the agent. All the diethylene glycol passes through the stripping column.

Equilibrium dew points for diethylene glycol are given in Fig. 6. In addition to these equilibrium data, losses of diethylene glycol by "evaporation" into the gas are important, for the agent is rather expensive. The best data available on this are given in Fig. 7. The effect of pressure on such losses is to reduce them directly in proportion to the increase in absolute pressure.

History. At the present time the plant in point has not been in operation for a long enough time to provide operation data. The diethylene glycol losses apparently are reasonable. Assuming satisfactory operation the method promises to be the best of those yet tried. A great deal of work has been done on it by various companies, but brines have been favored.

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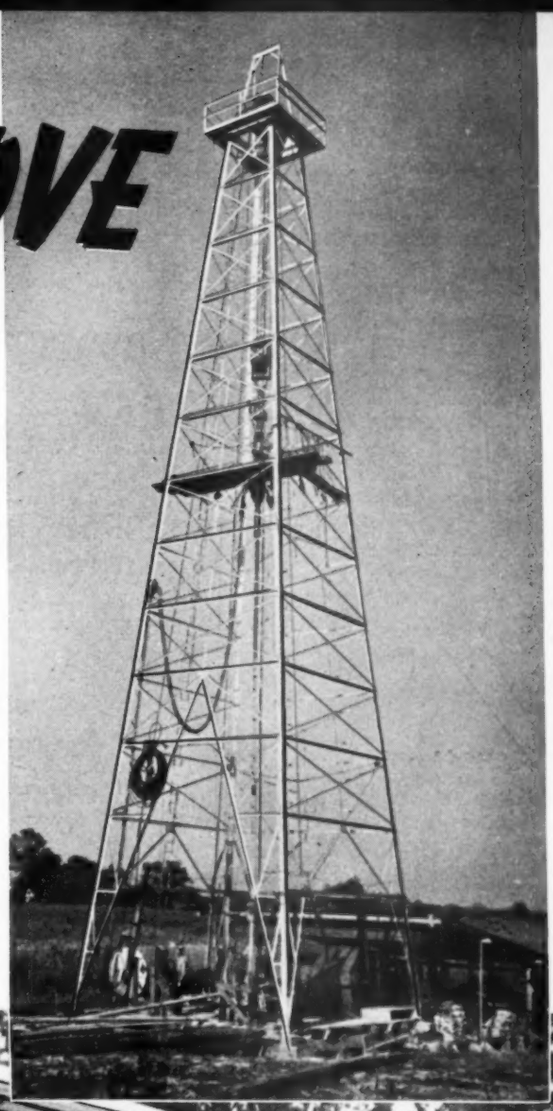

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Attaching the clamp for surveying a well by the oriented method; instrument is run on macaroni string

Comparisons of Methods Show Accuracy of Underground Surveys

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles, California

Degree of accuracy obtained with survey instruments has become an important factor in modern drilling technique

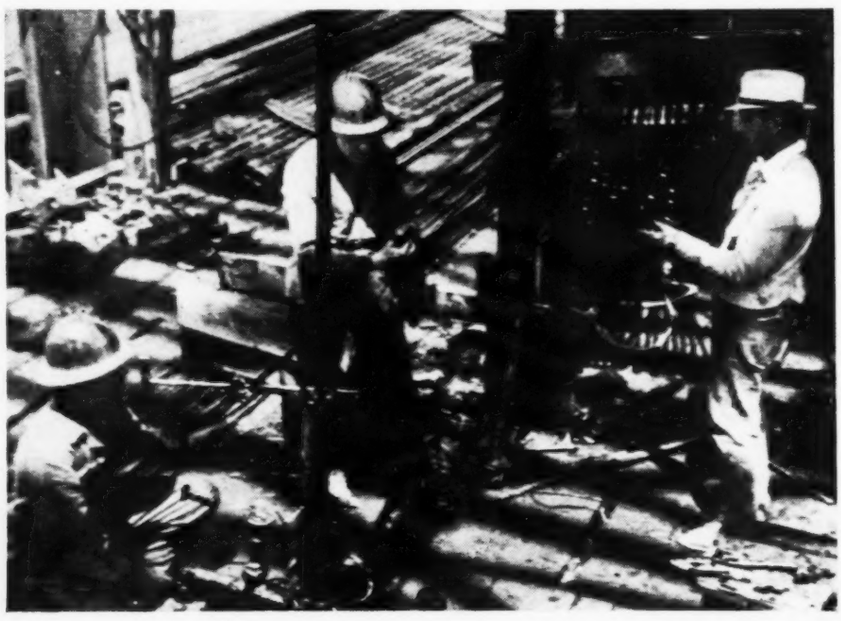
THE evident advantages derived from underground surveys of oil wells and from directional drilling—which depends upon survey readings for the control of direction—have made the use of survey instruments an important factor in modern drilling technique. Although the accuracy of underground surveys, both in drilling and completed wells, has been generally accepted for practical purposes, the actual degree of accuracy obtained is perhaps not fully appreciated. It is only by data accumulated over an extended period that the accuracy of present methods of underground surveys has been definitely established; and it is only by checking more than one distinctly different method with another that conclusive evidence has been produced. The results shown by the data herein provided are offered to indicate the degree of accuracy that can be expected in properly conducted surveys made with seasoned instruments and methods.

The first oriented survey of an oil well was made by Alexander Anderson in 1924. The instrument used automatically made successive photographic readings of inclination and direction at fixed time intervals as it was lowered down the well on drill pipe. The records thus made, when combined with the measurements of the rotation of the successive stands of drill pipe, supplied the data necessary for plotting the underground course of the well. This established the orienting method, which provides a complete survey of a well either in cased hole or in open hole. It now has been so developed, however, that the instruments are run on drill pipe, tubing, macaroni, or sucker rods, and surveys are made inside tubing as well as in cased or open hole.

Confirmation of the accuracy of the oriented method was made by verification of many conditions known to exist and by check surveys run at different times. More conclusive, however, were instances (of which there have been several) in which two wells would meet or in which cement or rotary mud passed from one well to another and the distance between the wells was shown by surveys made of the two wells. One such case is shown in Fig. 1.

The great drift of wells often disclosed by the first surveys showed the necessity for keeping a well straight while it was being drilled and led to the use of the acid bottle to measure the inclination of the hole during its progress. Mechanical and photographic instruments then were designed to replace the acid bottle. The measurement of direction, as well as inclination, soon was found expedient, however, and with the introduction of directional drilling became an absolute necessity. The photographic, magnetic single-shot survey instrument therefore was designed to meet the conditions and a means was thus offered to keep track of the course of a well as it was being drilled.

Photography is employed also in the



Taking a sight on the derrick floor while orienting in a string of macaroni

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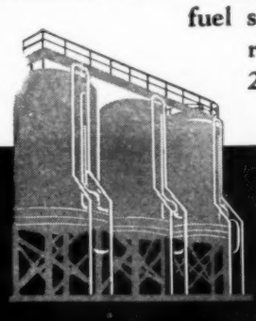

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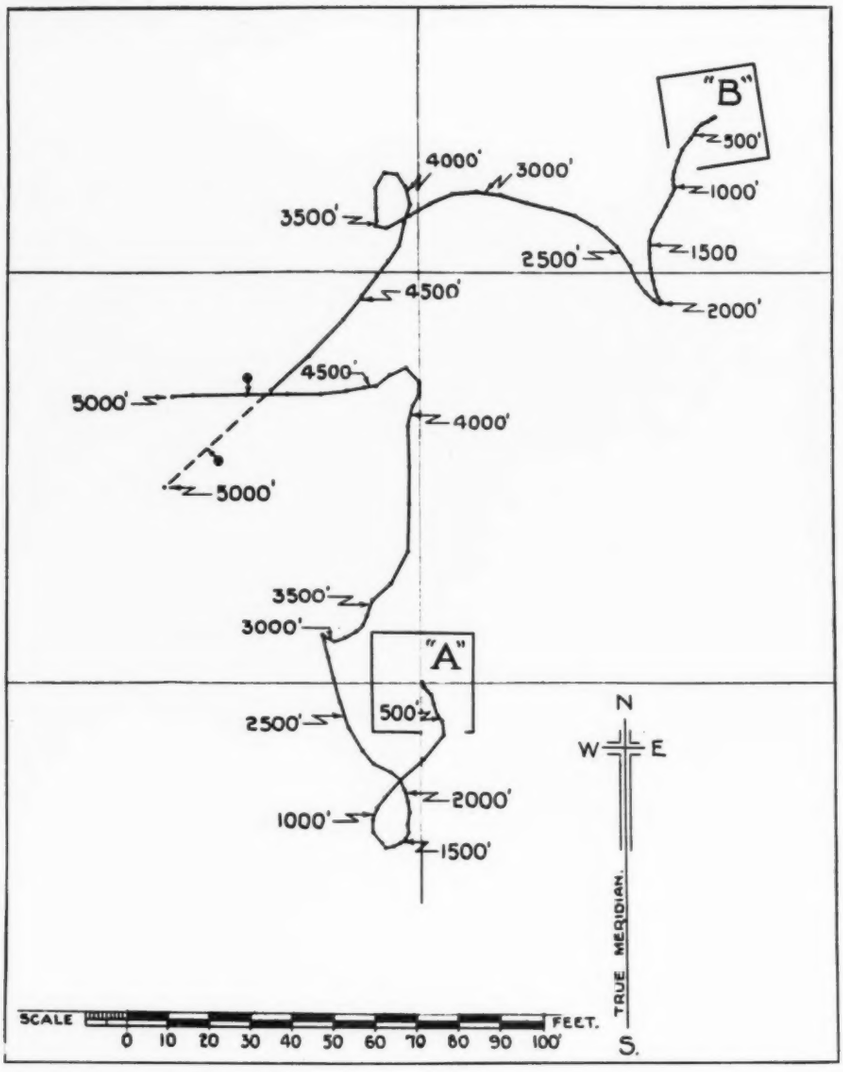

Fig. 1 (Above)

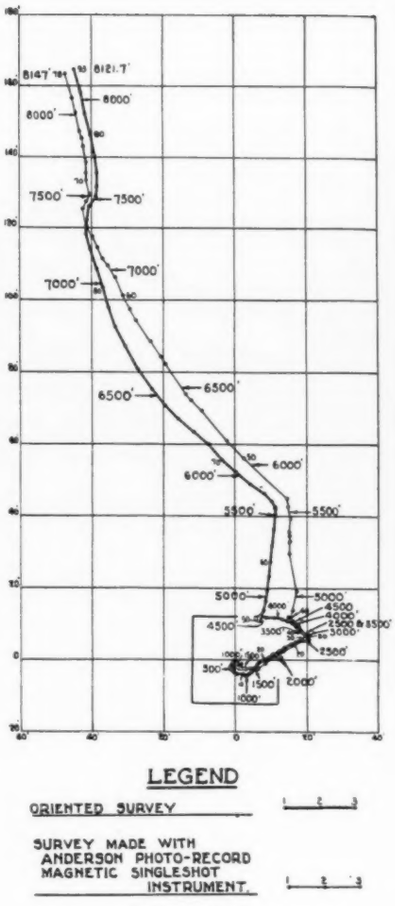

Fig. 2 (Above)

single-shot survey instrument to obtain a record, but the operating principle is entirely different from that employed in making oriented surveys. The single-shot device utilizes a plumb bob and compass and records their relative position at any point in the hole to which the instrument is run. The operation naturally is limited to readings in open hole; however, this is no disadvantage as the single-shot is adapted primarily for use in drilling wells. It provides information for the guidance of the wells while drilling and for plotting their course as they progress.

This instrument usually is run on a sand line, although it can be lowered to position in the hole on a string of pipe when a sand line is not available. By using the very small diameter single-shot instruments developed recently, surveys also can be made with retractable coring equipment by means of which the instrument is lowered

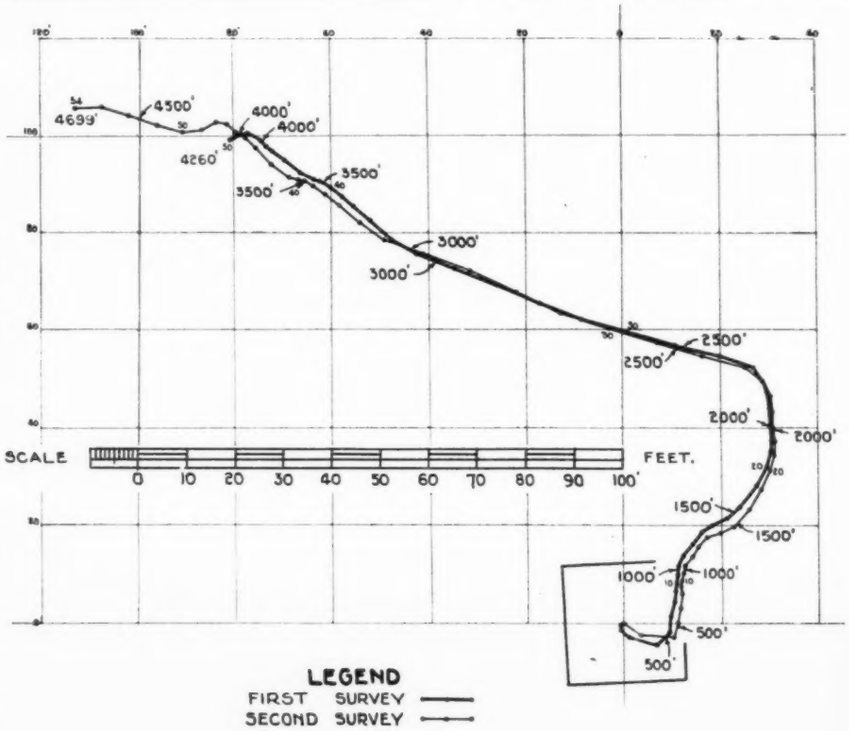

Fig. 3

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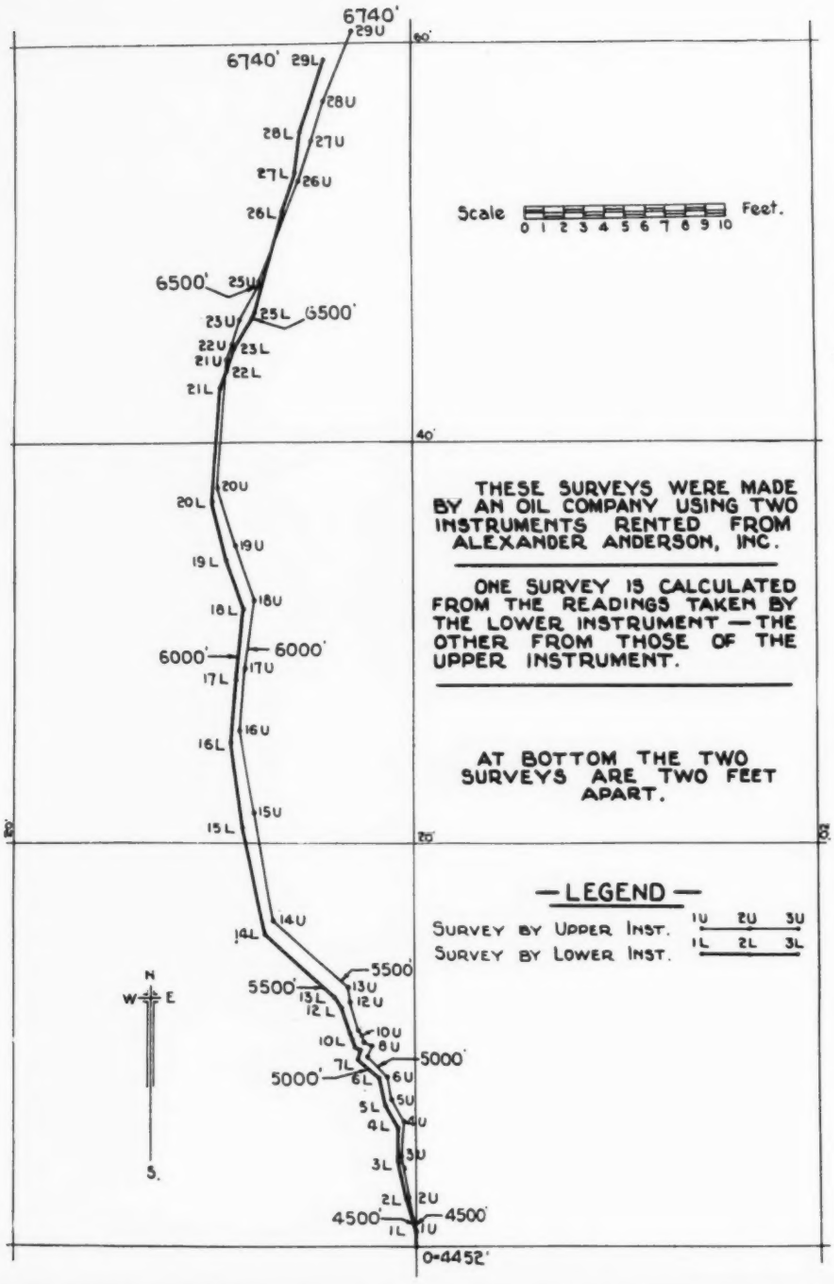


Fig. 4

through the drill pipe to project into the open hole below the bit.

With two entirely distinct methods thus offered by the oriented survey and the magnetic single-shot instrument, a comparison of the underground course disclosed for the same well by the two methods will indicate the accuracy that can be expected in oil-well surveying. This is especially valuable when the course of a well is plotted during drilling and is checked by the oriented method after the well is completed. A comparison of check runs made by the same method at different times provides further data on the accuracy of each type.

Comparison of a Single-Shot Survey with an Oriented Survey

The plans of one well as plotted from two surveys are shown in Fig. 2 The first survey, shown with the lighter line, was made with a photo-record magnetic single-shot instrument run on a wire line in open hole, during the drilling of the well. Data for the plat were procured from 78 separate readings. The other survey, plotted with a heavier line, was made by the oriented method during one run into the well after the well was completed and the hole cased. At the measured depth of 8000 ft. in this well, the position of the well, as shown by the two separate surveys, falls within a circle less than five ft. in diameter.

Comparison Between Two Oriented Surveys

Of particular interest is the comparison of two oriented surveys made of a well with a lapse of five years between the surveys and with the sub-

Fig. 5 (Below)

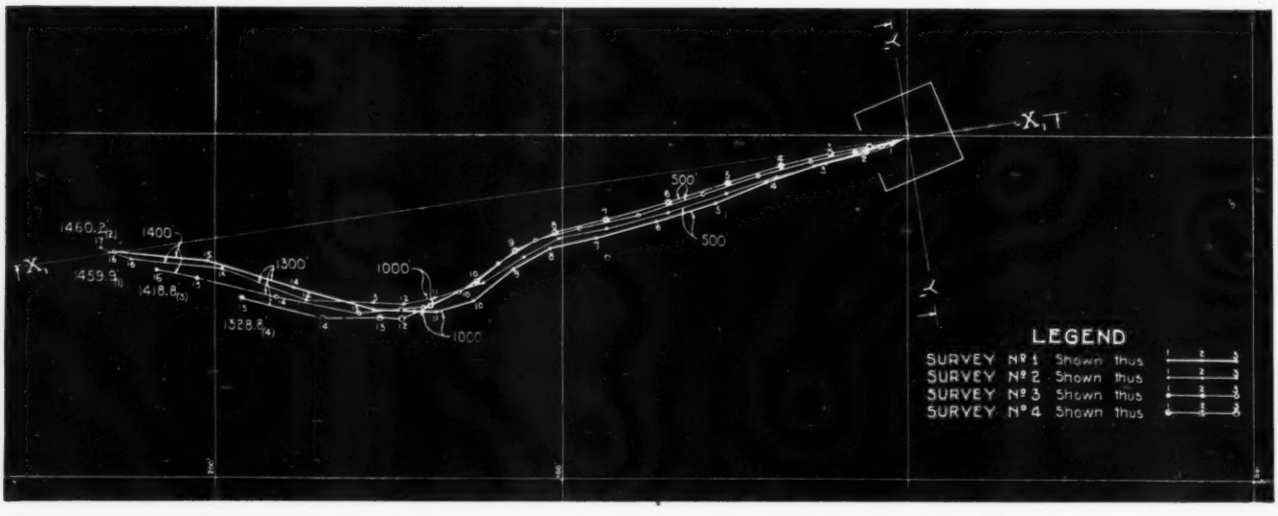
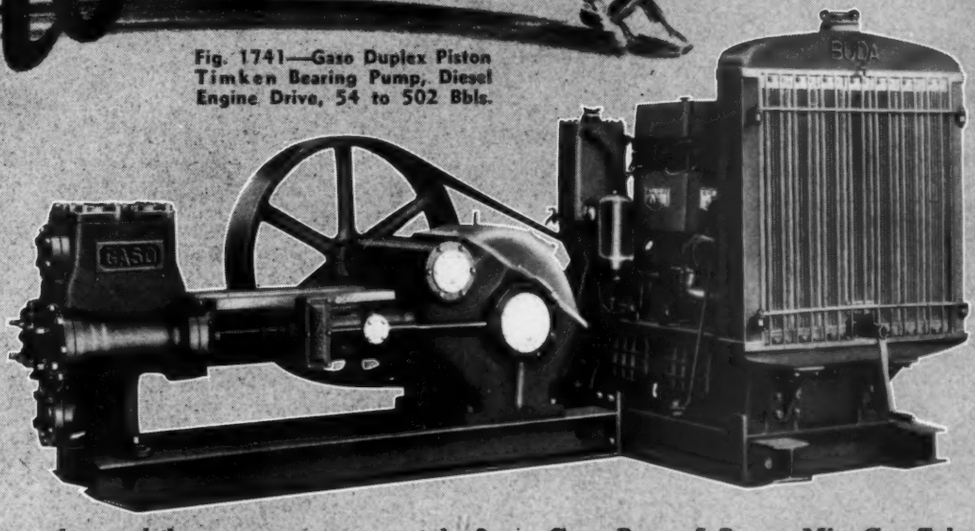


Fig. 1741—Gaso Duplex Piston Timken Bearing Pump, Diesel Engine Drive, 54 to 502 Bbls.



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Orienting 1¼-in. tubing into a well for survey. The upper sight is clamped onto the string up in the derrick and reading taken before it is lowered into the hole

surface condition of the well materially changed. These surveys are shown in Fig. 3, the heavy line indicating a survey run in 1929 and the light line a survey run in 1934. The first survey was made by orienting the instrument on 5-in. drill pipe in open hole; the second by orienting another instrument on 2½-in. upset tubing inside 5¾-in. casing. Although the conditions under which these surveys were run were obviously very different, at the measured depth of 4000 ft. the two surveys are approximately four ft. apart.

Comparison of Two Single-Shot Surveys

As a check both on the accuracy of the magnetic single-shot instrument and on the degree of accuracy with which the records can be read, one operator in California, using a double-length outer case, ran two single-shot instruments simultaneously. He thus obtained two simultaneous readings at 29 survey points during the drilling of a well between the depths of 4452 and 6740 feet.

The results obtained are given in Fig. 4, where the light line designated "U" shows the plat made from the upper instrument readings and the heavy line designated "L" shows that made from the records of the lower instrument. The surveys were calculated separately and, as can be seen from Fig. 4, the two instruments checked each other within two ft. at bottom.

Legal Cases

A number of cases of trespass have been tried in the California courts. In all these cases oriented surveys were ordered by the court and these surveys were accepted as evidence to prove the underground locations of the wells in question.

As such wells generally are cased, either totally or in part, comparative surveys cannot be made by magnetic instruments. More than one survey, however, can be run and the checking of two or more such surveys with each other provides data on the accuracy of the results. In a recent case four surveys were made of a well in litigation, with the results as shown in Fig. 5. It was necessary to run these surveys inside 3-in. tubing, so a small multiple-shot recording instrument capable of taking 170 successive photographic records was employed. This apparatus was inclosed in a waterproof case of 1½-in. diameter.

Two of these surveys were made on ⅞-in. diameter sucker rods and two on 1¼-in. macaroni tubing. As an additional check, the survey readings were taken at different points during each run to give four different sets of reading depths. This was done by using sucker rod stands of one length and tubing stands of another length and by beginning the second survey of each pair with a half stand.

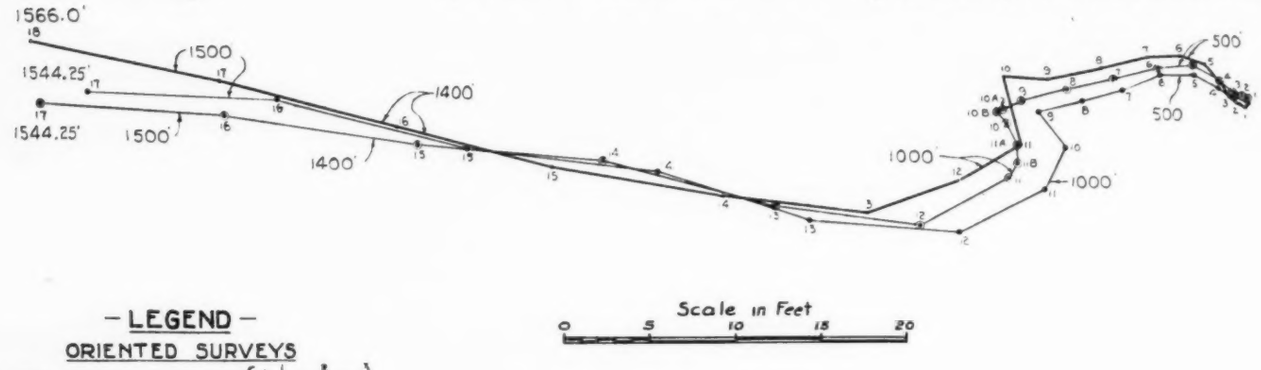
Two such different media as ⅞-in. sucker rods and 1¼-in. tubing were employed in order to meet any argument that surveys run on such slender supporting means are liable to large errors due to twist in the rods or tubing. As the stiffness, in respect to twist, of the tubing employed is three and one-half times greater than that of the rods, a twisting force would give entirely different results with the two media used. Any twist would throw the directions off to such an extent that the surveys might show the hole going in opposite directions. Actually, as can be seen in Fig. 5, all four surveys followed each other very closely; the three surveys carried beyond the 1400-ft. depth being within five ft. of each other on a horizontal plane at their deepest point.

As a further comparison between oriented surveys, Fig. 6 shows three such surveys run in one well using sucker rods and drill pipe. The first two were made on ⅞-in. sucker rods and were run inside 4-in. drill pipe. The third was run on 4-in. drill pipe. The difference in the effect of twist on two such media is even greater than between sucker rods and tubing; yet the three surveys are less than three ft. apart on a horizontal plane at 1500 feet.

Conclusion

The comparison of surveys made in the same well by two different methods (the orienting and the magnetic) and under different conditions (in open hole and in cased hole) has demonstrated the remarkable accuracy that is being obtained in first-class underground survey work. The further com-

Fig. 6



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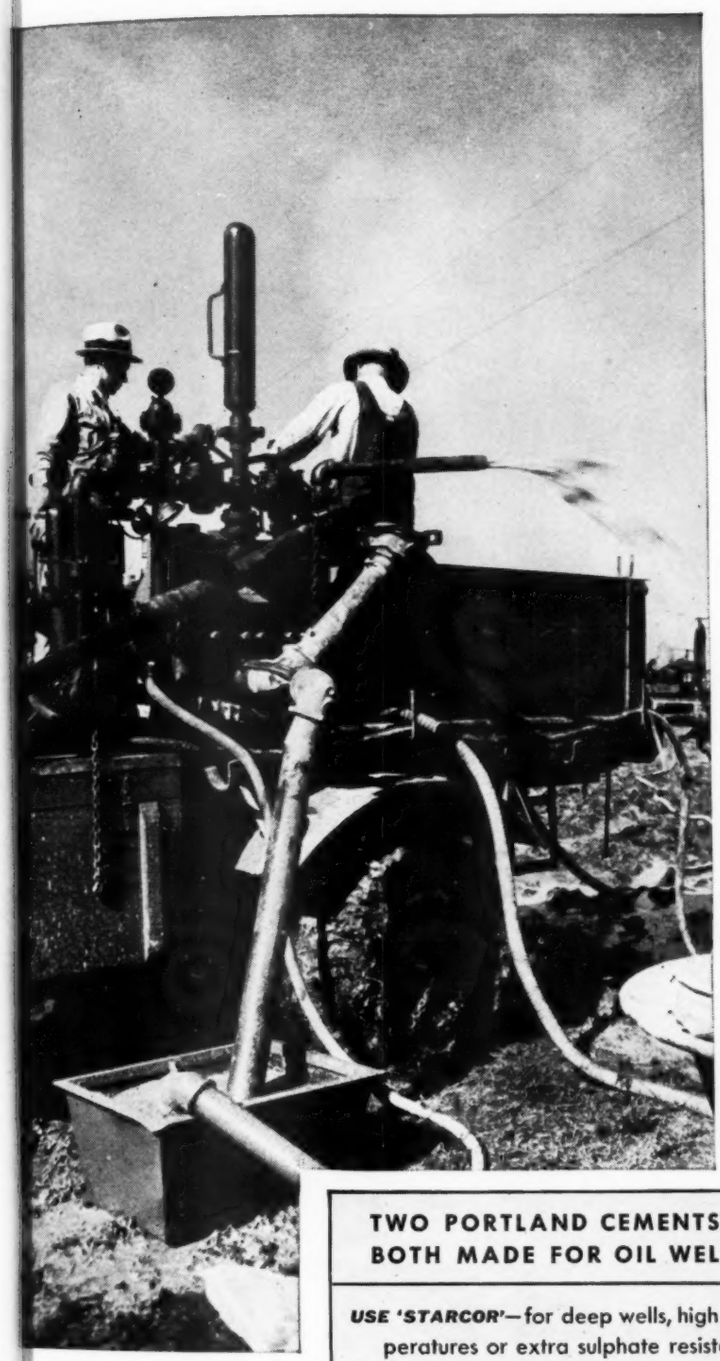

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parisons of oriented surveys made at different times after the subsurface condition of the well has been radically changed and of others made by the use of different media on which the instrument is run in the same hole, however, have added to the confidence that can be placed in oil-well surveying.

In fact, the small instrument used for making oriented surveys on sucker rods and macaroni tubing really is different from the larger instrument used with drill pipe. This gives an additional check to the oriented method. The magnetic single-shot method now so widely used in directional drilling and in keeping wells straight and within the boundaries of the owner's lease has been so checked with the oriented surveys, which themselves have been double-checked, that reliable data can be obtained when good instruments and scientific methods are employed and the proper care is taken in their operation.

Oriented surveys should be made with a trained field crew and calculated under the supervision of an engineer. The magnetic single-shot, however, can be operated by the drilling personnel when familiar with its simple operation. The results of the survey are easily calculated. The photo-record magnetic single-shot survey instrument used in the above-described surveys requires no mathematics or any knowledge of photography for its use and provides a record that is direct reading for both direction and inclination.

USEFUL CHART FOR DETERMINING EXPANSION

By

W. F. SCHAPHORST

THE accompanying chart is useful for determining the expansion in piping, rods, tubes, beams, shafts, columns, chains, etc., for any ordinary temperature difference. It makes "longhand figuring" unnecessary.

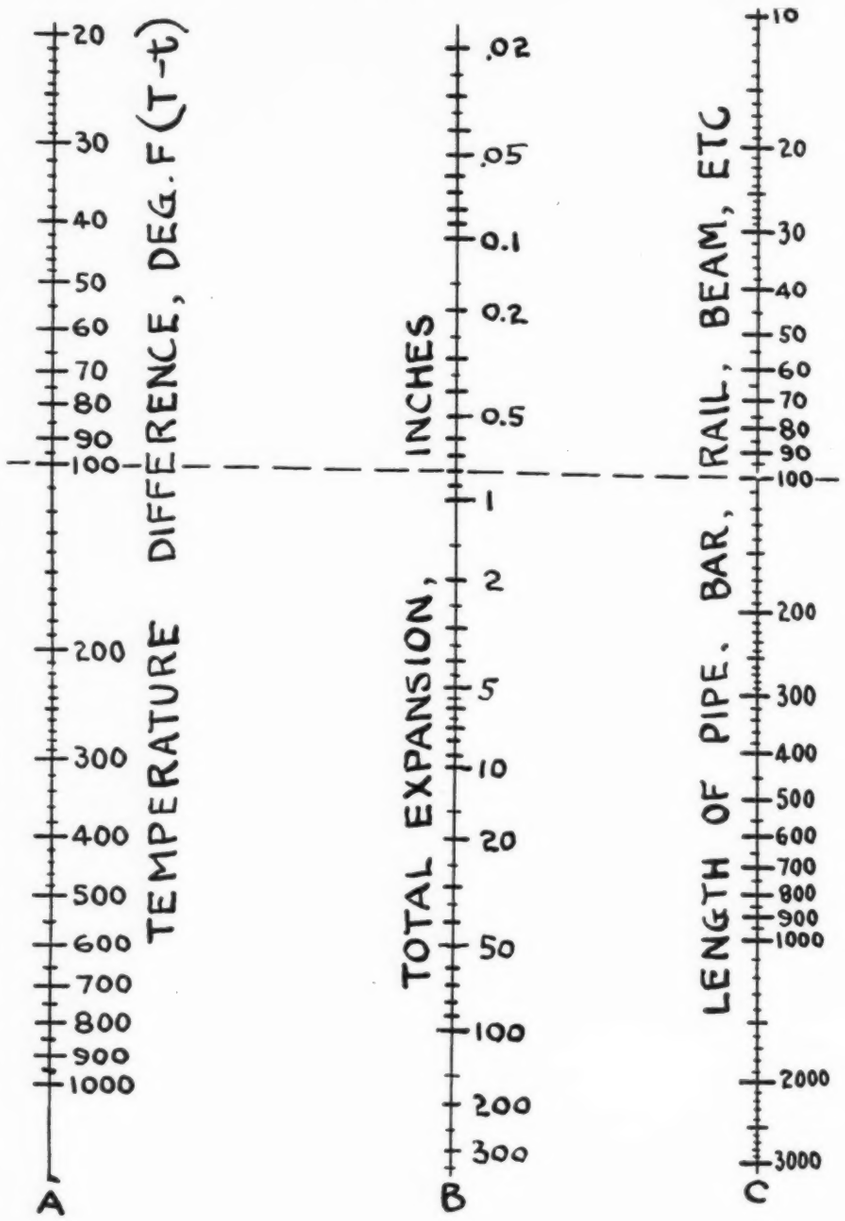
Simply lay a straightedge across the chart once or stretch a fine black thread across, as indicated by the dotted line, and the problem is solved.

Thus if a certain pipe line 100 ft. long is subjected to a temperature variation of 100 deg. fahr., what will be the total expansion in inches?

Simply connect the 100-deg. temperature difference, column A, with the 100-ft. length, column C. The intersection with column B gives the answer as 0.8 inch. That is all there is to it.

The chart also can be used for determining the allowable temperature difference where a definite amount of space is available for expansion and contraction. Thus, if the length of the pipe is 100 ft. and the allowable expansion is 0.8 in. the same line would show that a temperature difference of 100 deg. fahr. would be the limiting amount. Or again, if the factors in columns A and B are known, the unknown in column C is immediately found. In other words, if any two of the factors are known the third is quickly found, and without any computing whatever.

The range of the chart is wide enough to care for almost any expansion or contraction problem. The temperature difference, column A, varies all the way from 20 deg. to 1000 degrees. Seldom, if ever, do we have as high a temperature difference as 1000 degrees. The length of pipe line, also, is great, varying all the way from 10 ft. to 3000 ft., and the total expansion between these limits varies all the way from 0.02 in. to 300 inches.



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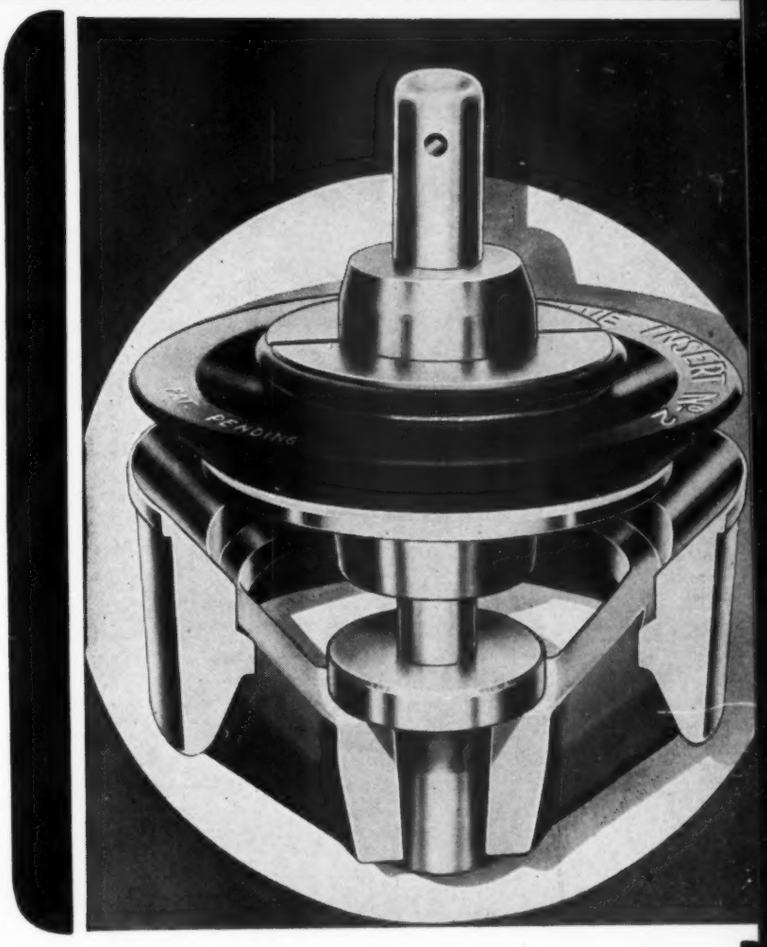

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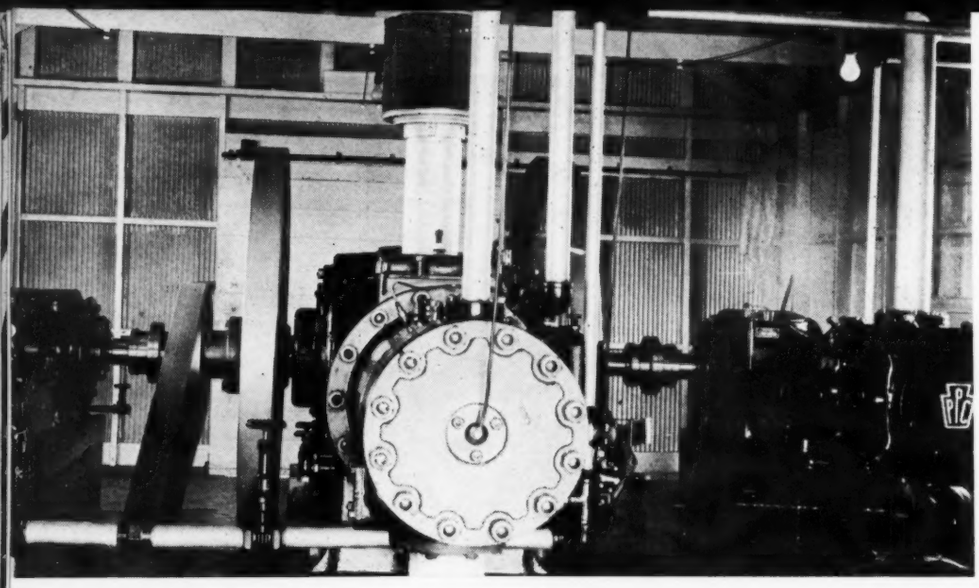


Interior of repressuring plant in the Sunnydale area, Ohio County, Kentucky, with air cylinder on one side of a gas engine and gas on the other

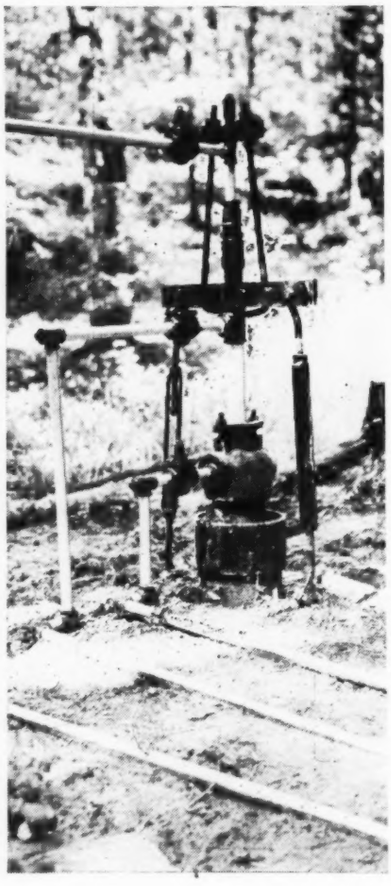
By
J. C. ALBRIGHT

Repressuring Depleted Sands In Kentucky Fields

Many difficulties to overcome in initiating repressuring programs due to lack of adequate records

SINCE the western Kentucky oil fields were discovered some 20 years ago, many thousands of barrels of oil have been removed from the various sands; however, an accurate record has not been kept to indicate to one interested in secondary recovery methods just how much oil has been produced from any given lease. Many small carriers have disappeared from the present picture and the records lost, or destroyed, as being of no future value. As a result, it is next to impossible to establish definite figures regarding the amount of oil in place at the time each pool was discovered. In some instances, existing pipe lines have been operating since the discovery of oil, and have records of pipe line runs from each farm and lease in their districts. These records, in many instances have been buried in the files of the companies so long that many weeks may be required to find them and compute the total volume of oil to date.

In the absence of accurate records, it is estimated that considerably more than 20,000,000 bbl. of oil have been produced in the 20 years, the principal part coming from the Chester, in the upper Mississippian, which is divided into several zones. The top sand, or that producing formation lying nearest the surface of this rugged country, is the Stray sand, deposited by an old river bed, and is quite prolific, but covers a limited area. Next below is the Jett sand, found in nearly every well drilled, but somewhat lenticular, and the edges grading to impervious rocks too tight to carry either oil or water. The Jones, Jackson, Barlow, and Bethel follow one another beneath quite regular intervals of shales and limestone, and all, like the Jett sand, are lenticular in many parts of the country and more productive in the center of the lenses than on the edges.



Close-up of input well showing method of connecting three lines for repressuring different sections of the Jett sand in Ohio County, Kentucky

The dip of these sands is toward the west, where the lowest part of the Illinois basin in Kentucky is found south of the Ohio river, and rising to a shallower depth eastward to the Cincinnatti Arch. The Jett sand, being the most prolific of the oil formations, outside the restricted area where the Stray is found, lends itself more easily to secondary recovery methods than any of the lower sands, and because of its shallowness has been exploited to a greater degree. The depth below the surface is governed by two factors: first, the dip towards the west; second, the topography. In most parts of Daviess and Ohio counties, the average well depth is approximately 500 ft., the sand thickness varying from thin sections to as much as 40 ft. in the most prolific parts of each pool.

As the wells were drilled and produced under old methods that took no thought toward conservation of natural reservoir energy, and as a consequence the gas is almost completely gone in the majority of the older pools. Vacuum has been applied in many fields and an attempt made to increase the per well production; this has been a contributing factor in rapid depletion. Repressuring has been carried out under difficulties, due to the absence of gas in the natural state, requiring the producer to purchase gas at almost

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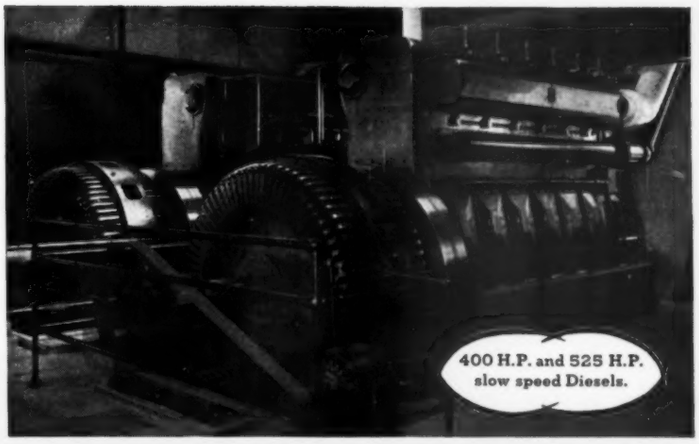
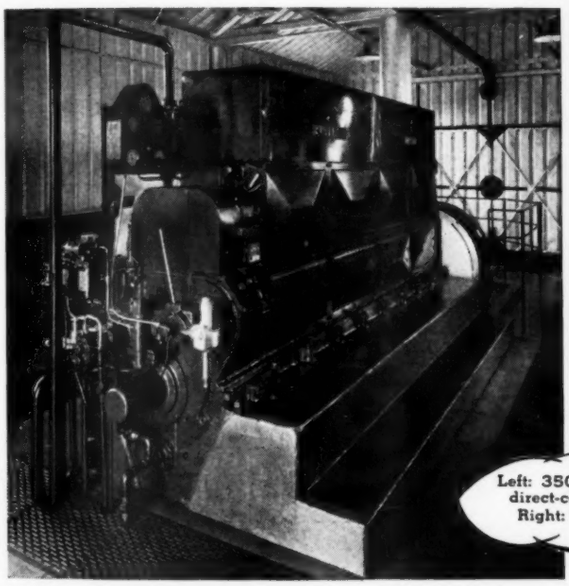
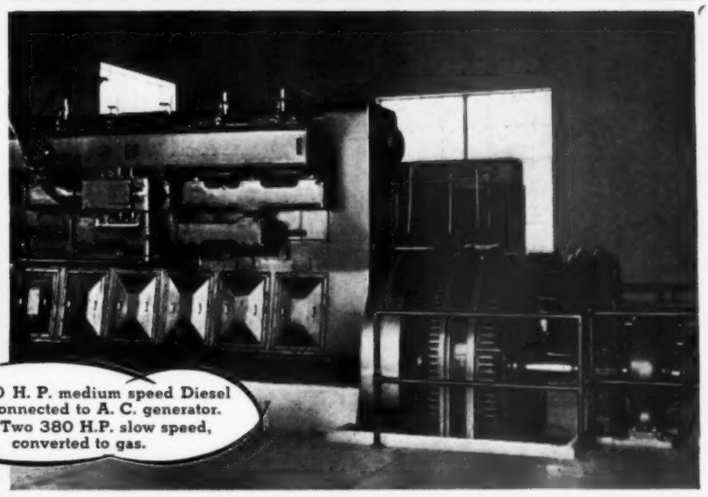
—20 to 800 H. P.

Portable generator units up to 350 H.P.



400 H.P. and 525 H.P. slow speed Diesels.





Left: 350 H. P. medium speed Diesel direct-connected to A. C. generator. Right: Two 380 H.P. slow speed, converted to gas.

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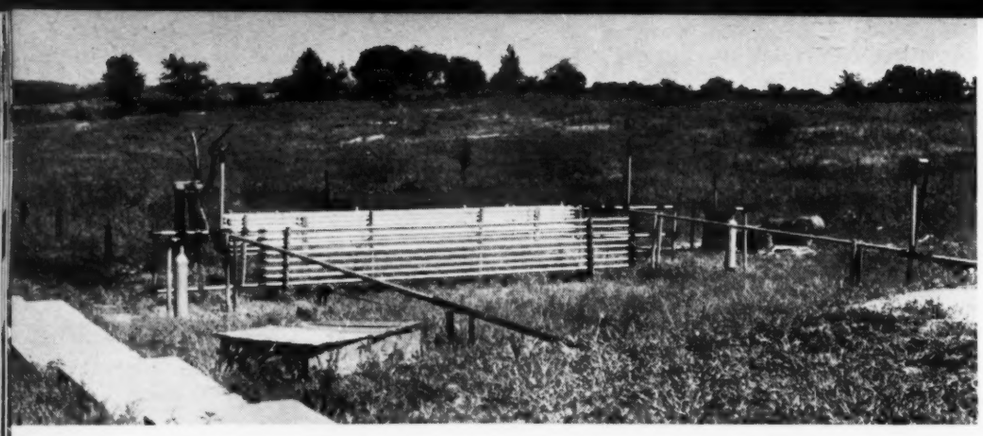
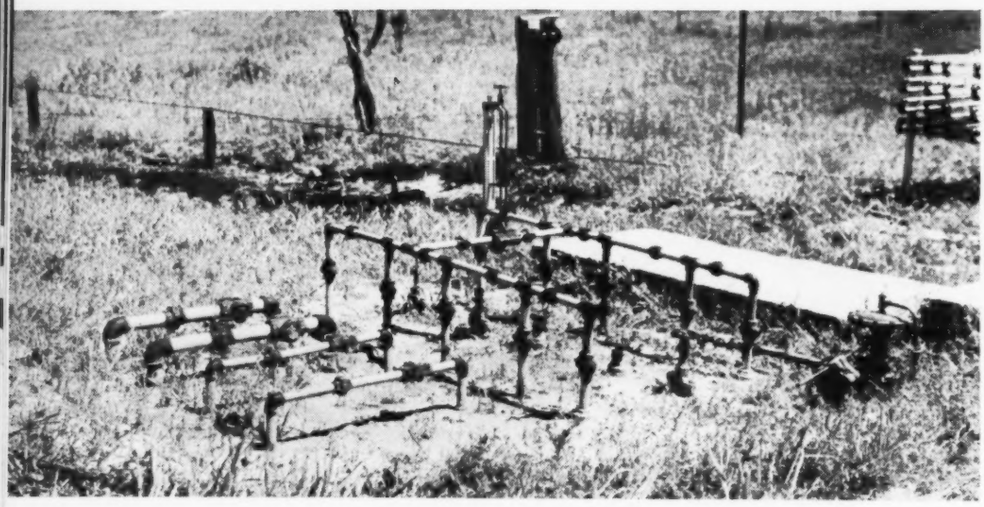
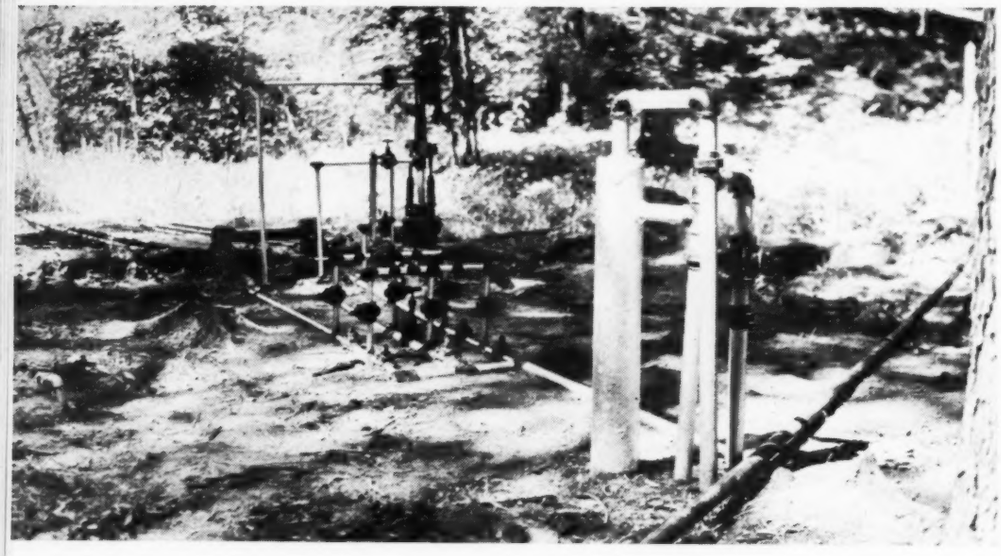


Air and gas cooling coils in open to reduce temperature by aid of atmosphere on Sunnydale leases in Ohio County, Kentucky, repressuring project



Air and gas distribution manifold on Sunnydale leases, Western Petroleum Company, used to direct air or gas to various parts of the field for repressuring



Input well on the Mary Elmore lease where three sections of the Jett sand are being repressured, each of which requires different pressures

prohibitive prices, or inject air at the beginning of each project.

Well data are almost entirely absent in most cases, as the wells were drilled with no other purpose than to reach the sand in minimum time, crooked holes or otherwise, and drilling records are few and incomplete. Outcrops of the sands farther to the east reveal numerous shale intercalations throughout the formation, at varying distances apart ranging from a fraction of an inch to several inches. From some cores removed from wells recently drilled, permeability tests could not be obtained due to microscopic shale layers that did not show until the biscuit was broken crosswise and examined under a glass. The distance between the shale partings varies with the thickness of the sand, being more widely spaced in the thicker parts of the sands than at the edges. Vertical shale partings have not been discovered in any exposed beds, nor in any cores taken to the present time; all those found are parallel to the bedding plane. Horizontal permeability varies considerably, running from greater than 80 millidarcies to almost zero permeability. This condition is so frequently encountered that many wells have been equipped for repressuring to take advantage of as many as three strings of pipe to introduce the gas, or air, to the particular portion of the sand desired.

Application of repressuring to pools in western Kentucky has met with many obstacles, among which is the apathy of the adjoining lease owners towards the project, and the reluctant attitude of the lease men toward applying pressure to pumping wells. Leases for the most part are small, and to obtain the greatest benefit from any repressuring project it is desirable that it be a unit operation. This is next to impossible due to the number of the small companies and getting them to cooperate in such a project; and also because of the lack of sufficient capital properly to equip the leases. During recent months a more liberal attitude has been taken by the producers generally, and pumpers and lease men, after becoming acquainted with projects on adjoining leases or in the next township, have been eager to obtain larger returns for their companies, and cooperate with the engineers to a greater degree than formerly.

Proponents of vacuum, as applied to depleted pools in western Kentucky, contend that a larger part of the residual oil can be obtained by this method, and economically and with a minimum of supervision; but change their attitude when they are shown analyses of cores taken from such properties indicating large reserves yet in the ground. Efforts on the part of the Department of Mines and Minerals and the Kentucky Oil and Gas Association have been of great value by showing that greater returns may be obtained by repressuring depleted sands than by any other permitted method. Waterflooding is not permitted because of legislative acts that prohibit the introduction of water into a producing

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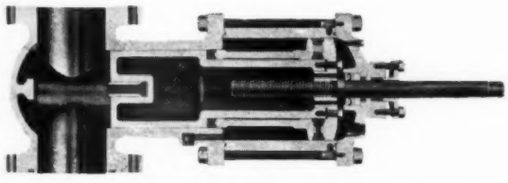
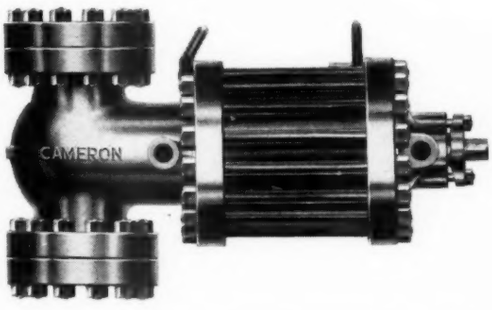


When fluid pressure is applied to closing side of ram-gate operating piston, ram-gate moves swiftly across horizontal bore and seals instantly on single seat formed integrally with self-cleaning gate cavity.



Exterior view of Cameron Pressure Operated Gate Valve. Note closing and opening ports which require very simple manifold. Control is by means of a 4-way control valve. Operation is instantaneous and exceedingly positive.

With a Cameron Type SDA Pressure Operated Blowout Preventer on your well, you enjoy the protection of the world's fastest, most positive and dependable unit for sealing the annular space.

But, even an "SDA" preventer can seal only the annular space. There remains an equally vital opening to shut off in event of a vicious well blow . . . the flowline outlet.

At this point, only a Cameron Pressure Operated Flowline Gate Valve can match your Type SDA Preventer in speed, positive closure and leak-proof seal.

In the cross-section view, at left, of a Cameron Valve, note that a single seat is built into the self-cleaning gate cavity. Against this, when a shut-off is required, the massive ram-gate fitted with self-feeding packing element slams instantly when closing pressure is applied. Regardless of how rough or corroded the seat may have become in hard service, the self-feeding packing element seals off all inequalities instantly.

The cost of a Cameron Pressure Operated Flow-Line Gate Valve is negligibly little more than that of a conventional gate valve, considering the vitally important service it renders. To operators who feel that their rigs deserve the utmost protection against blow-out destruction, full and complete details of the Cameron Pressure Operated Gate Valve will gladly be forwarded without obligation.

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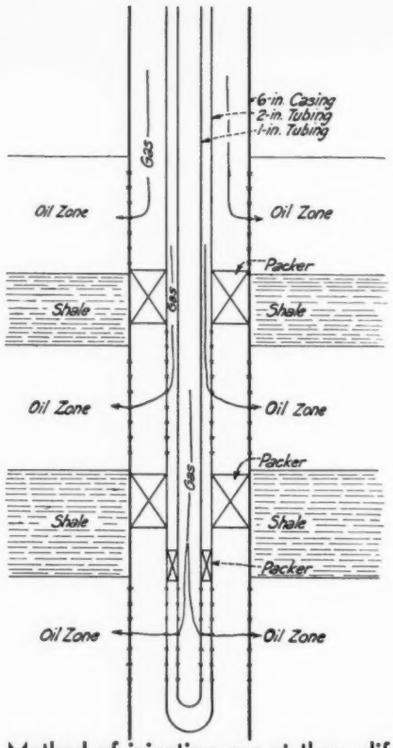
formation, accidentally or otherwise, and when a well is found to be leaking, steps must be taken immediately to remedy the situation.

In repressuring in Daviess and Ohio counties old wells have been used to a great extent for input purposes; newer projects however, drill new wells for this purpose and also to obtain cores for analysis. When old wells are utilized, generally the casing is tested for leaks. Usually it is found to be in fair condition. Oil in this part of Kentucky is usually sweet, and the waters are not particularly corrosive, accounting partly for the condition of the casing and seats above the sands. Repressuring projects have not adopted generally a five-spot or other pattern; producers depend more upon the size of the lease and the location of the producing wells than on other factors when selecting a well for injection of gas or air. Unless a producer has title to an entire pool he often finds that an adjoining property is being operated with a vacuum on the wells, and consequently more often than not, he applies vacuum to his edge wells to prevent the pressure from escaping to neighboring properties. Line wells are held under a vacuum proportionate to those across the fence, or road, and the input, or injection, wells are as far from the boundary line as possible.

The relative benefits derived from repressuring versus vacuum can be illustrated by citation of two leases, each containing approximately the same number of wells, the same thickness of sand, and the same quantity of residual oil in place. Both had been pumped for many years without either vacuum or repressuring, and there was little or no gas at the casingheads. Production averaged approximately one bbl. a



Method of injecting gas at three different pressures to three separate oil zones

well for several years before secondary recovery methods were applied. Both properties, owned by the same company, were equipped at about the same time and compressors, vacuum machinery, and gas engines were installed on the leases. The lease to which vacuum was applied was producing an average of 35 bbl. daily, and the one employing repressuring methods was making approximately 30 bbl. daily. Three months after vacuum was applied, production increased sharply to a peak of 180 bbl. daily, holding that volume only a very short time, when it declined as rapidly as it increased. Within about the same period of time, on the repressured property production increased at approximately the same rate as on the vacuum property, to 180 bbl. daily, but during the elapsed year has not changed appreciably, and then only during difficult operating periods, such as backwater from the Ohio flood in the spring of 1937. By the beginning of 1937, production from the property on vacuum had declined to 50 bbl. daily, and on July 25th was making substantially the same amount of oil as it had pumped before vacuum was applied. Repressuring was begun at that time, but sufficient time had not passed to obtain any results from the change-over.

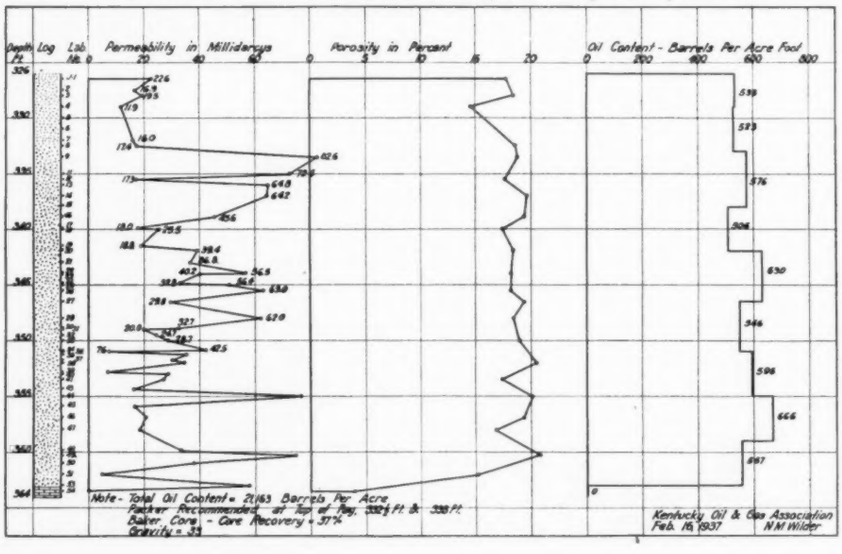
On the lease where repressuring was begun only enough gas was being produced to operate the power engines, and undiluted air was introduced into the input wells. After a period of about nine months the volume of gas produced from the pumping wells permitted a certain amount of recycling. Before the year was over, one side of the engine was fitted for handling gas, and the other for handling air alone. As pumping is done only for a part of each day, gas is introduced into the sand at night without admixture of air. The percentage of air in the gas, as shown by D'Orsat tests, indicates that the dilution is only about 18 percent.

On this particular lease, a well recently was drilled for input purposes, but the permeability of the Jett sand varied greatly in several places. Three major zones were plotted from the core analyses, each being separated from the other by heavy shale partings. (See accompanying plot of core analyses). The well was equipped for a three-pressure injection, using the 6-in. for the first string, and a 2-in. and a 1-in. for the other two. The 2-in. was packed below the more permeable strata at the lower part of the casing, and below the next strata so repressuring could be applied independently. The 1-in. string was packed in the lower end of the 2-in. string of pipe, and delivered air/gas to the last, or bottom permeable strata. Three separate lines were run from a distribution manifold at the well to deliver air/gas at the required pressure, as each was of different permeability and required high pressures in two of the sands, or divisions of the same sand, in this instance the Jett.

The volume of gas introduced to each well on these properties is equal to about a gas/oil ratio of 3000 cu. ft. per bbl. of oil; a greater volume has a tendency to cut so-called channels through the sand. When a well

(Continued on page 74)

Information plotted from core analyses showing three separate productive zones


Depth Ft.
Log
Lab. No.
Permeability in Millidarcys
Porosity in Percent
Oil Content - Barrels Per Acre Foot
Note - Total Oil Content = 2163 Barrels Per Acre
Packer Recommended at Top of Pay, 332.4 Ft. & 338 Ft.
Baker Core - Core Recovery = 57%
Gravity = 33
Kentucky Oil & Gas Association
Feb. 16, 1937
N.M. Wilder

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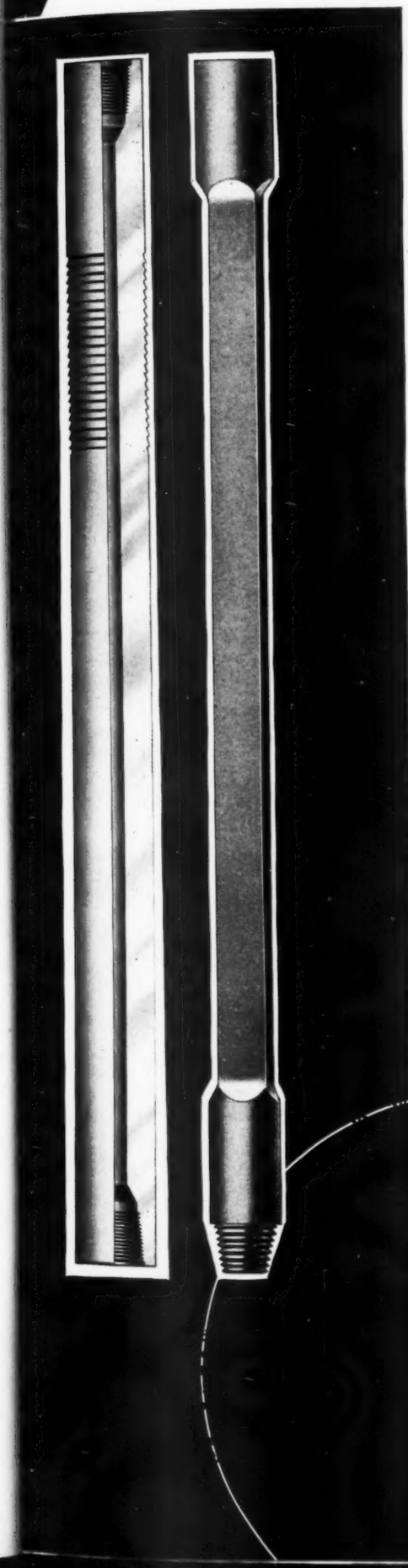
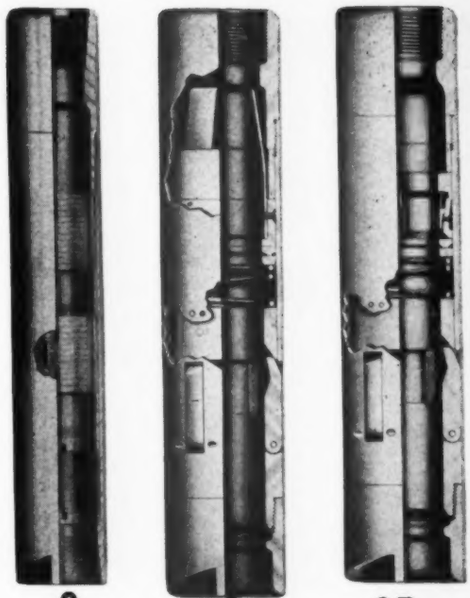
SAFE, MODERN OIL TOOLS!



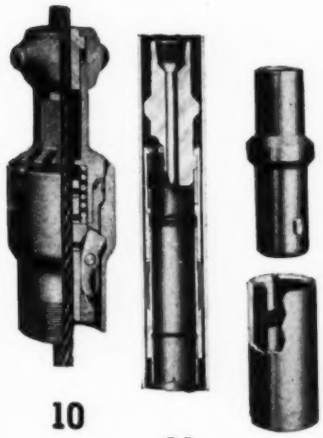
8 The Packing Casing Bowl effects a permanent connection between new casing and the casing remaining in the well after a defective section has been removed.

9-9A The External Drill Pipe Cutter is run on washover pipe. The cut is quickly made by rotating the fishing string, and the cut-off pipe is retained in the washover pipe by the overshot springs while being withdrawn from the hole. Interchangeable slip assembly (shown in 9A) adapts this cutter for cutting external flush joint drill pipe.

10 This non-sparking oil saver closes the well and allows all of the fluid to be expelled through the flow lines while the well is being swabbed or bailed. Automatically opens, closes and seals.



8 9 9A



10 11 12

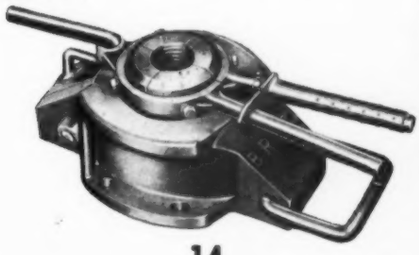
11 Packing type Adapter is attached to the top of the liner and permanently seals between the liner and casing. Easy to set and release.

12 The Baash-Ross Liner Setter and Adapter insure safety in running and removing liners of any length. (See Numbers 11 and 13 also.)

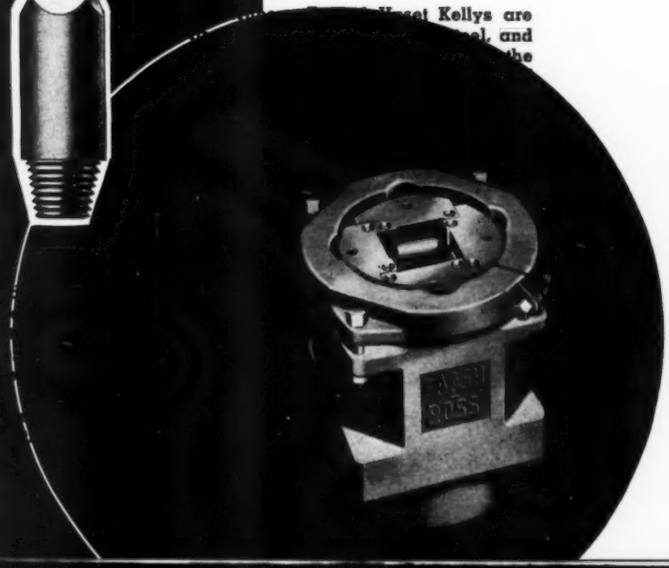
13 This packing-type Liner Hanger effects a permanent seal between the casing and the liner and supports the longest liner with safety. Releases easily when liner is to be pulled; can be used over and over again.

13

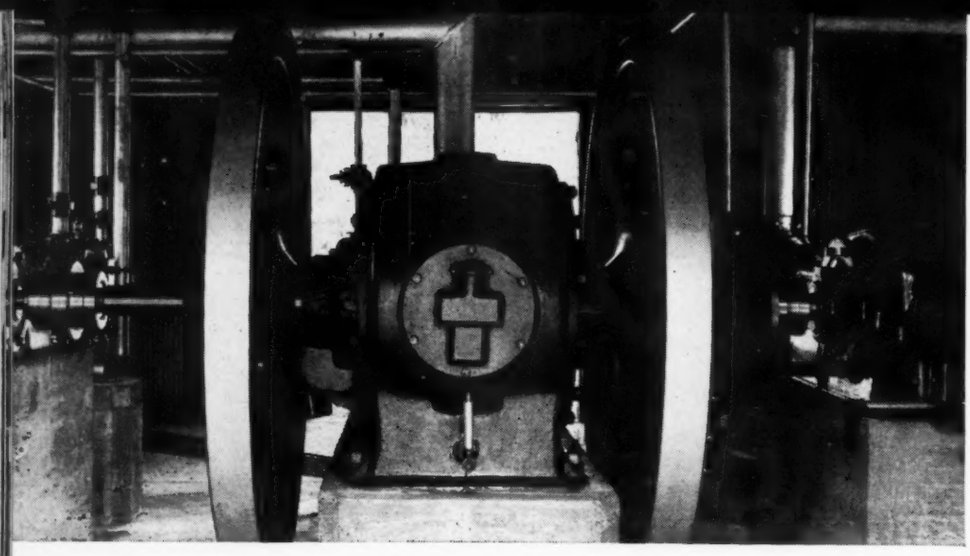
14 Open End Tubing Spider is installed without disconnecting flow lines. Slips are attached to self-locking tong and operated as a unit.



14



17 The full length rollers of the Roller Kelly Bushing insure even, controlled feed of kelly through rotary without binding when coring, drilling and fishing. Maximum driving surface with minimum friction.

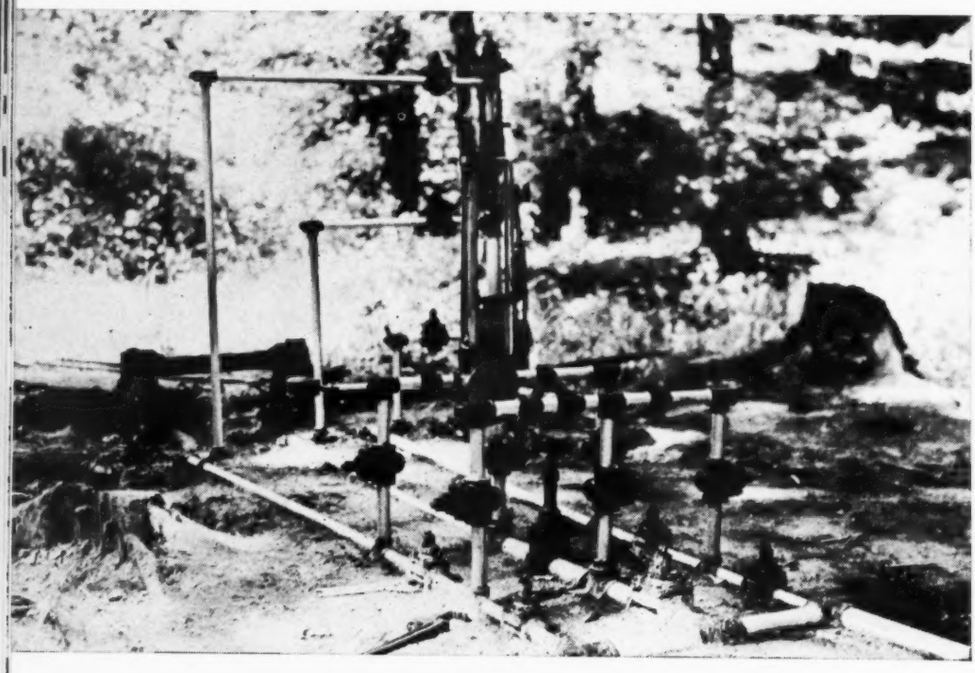


Interior of repressuring plant on the Mary Elmore lease

(Continued from page 70)

shows a larger gas/oil ratio, it is pinched back at the casinghead, and pumped under a greater pressure until the voids occupied by the gas or air again are filled with oil. Only one instance has been found on this lease in which such severe channeling has occurred that it could not be remedied immediately by applying back-pressure. The offending well was changed immediately from a producer to an input well, with the result that adjoining wells showed a surprising increase in oil recovered. The greater production from affected wells is explained in this manner: the channel is looked upon as being similar to a long perforated pipe running from the original input well to the channeled one, which, when utilized for gas distribution, permits a greater drive to be obtained than was possible with the usual sand distribution.

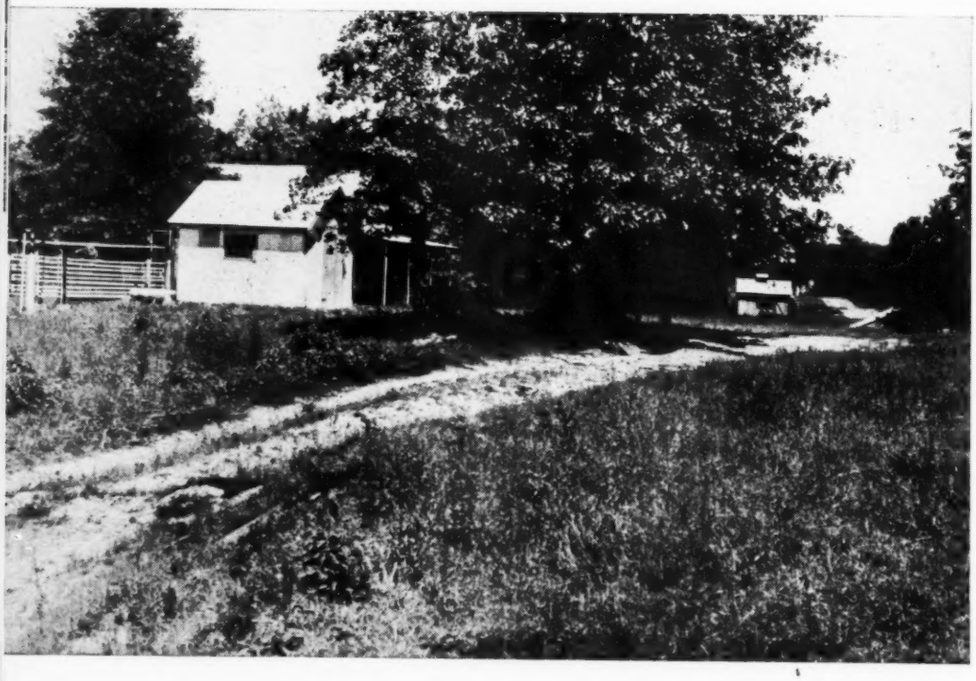
These two leases are equipped with 40-hp. gas engines, with compressors mounted on the crankshaft on either side, supported by concrete foundations, and alignment assured by flexible couplings. One has a 3-stage compression ratio, obtained with an intake cylinder, 10 in. by 10 in., and an intermediate one, 7 in. by 10 in., and the high stage, a single-acting cylinder,



Manifold on input well so that values can be ascertained without moving the orifice fitting

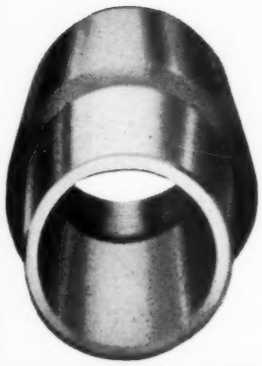
3 in. by 10 in. Small, to be sure, when compared with projects in other parts of the country, but sufficiently large for leases in Kentucky having from ten to 25 wells.

The average residual oil per ft. in the Jett sand, as determined by cores analyzed by the Kentucky Oil and Gas Association, is approximately 500 bbl., and on some leases analyses indicate that oil still in place is a much as 21,000 bbl. an acre. Lower pays have less oil than the Jett, averaging from 100 to 300 bbl. an acre-foot less than the Jett. Other sands have been repressured, but results have not been so gratifying as in the Jett; obviously they, too, will be subjected to secondary recovery methods after the Jett sand has been exhausted.



A typical scene in Ohio County, Western Kentucky, oilfield where repressuring has been instrumental in increasing production several hundred percent

COMPLIMENTS *the* A·P·I·



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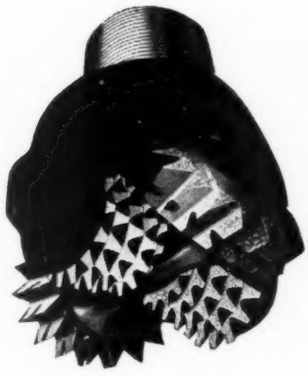
TOOL JOINTS



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REED
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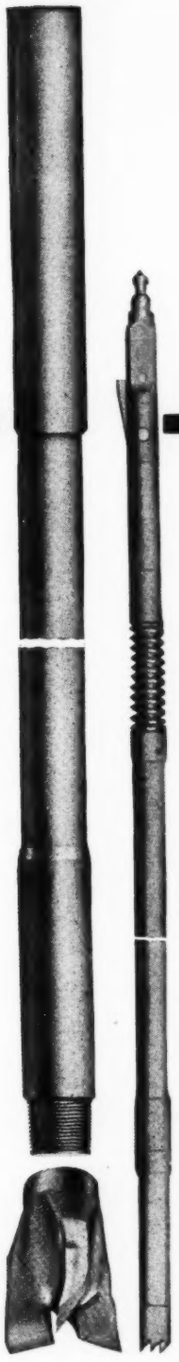

REED
B-R WIRE LINE DRILLING
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KOR-KING
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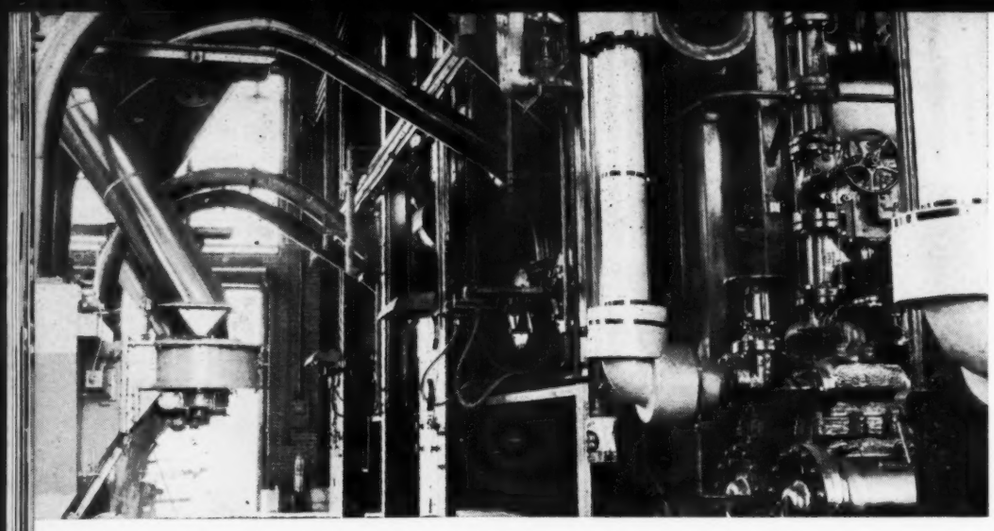


Looking down aisle of boiler plant of United Refining Company in Warren, Pennsylvania, showing front of 580-hp. boilers

United Refining Company's new steam plant at Warren, Pennsylvania, is one of largest ever built employing pulverized coal as fuel and depending on natural draft

Refinery Steam Plant Has Several Innovations « « « «

By M. J. GOODNIGHT

DURING 1937 the United Refining Company made an important addition to its refinery at Warren, Pennsylvania, by erecting a modern steam generating plant to provide power and process steam. The company had been operating its refinery with boilers that were more or less obsolete. Their capacity was overtaxed, and resultant efficiency low; coal and cracked residuum were used as fuel and firing was done by hand. With an expansion program under way that included the enlargement of its crude refining unit, construction of a new wax plant, and improvement of cracking facilities, the need for a greater supply of steam and its more economical generation became apparent.

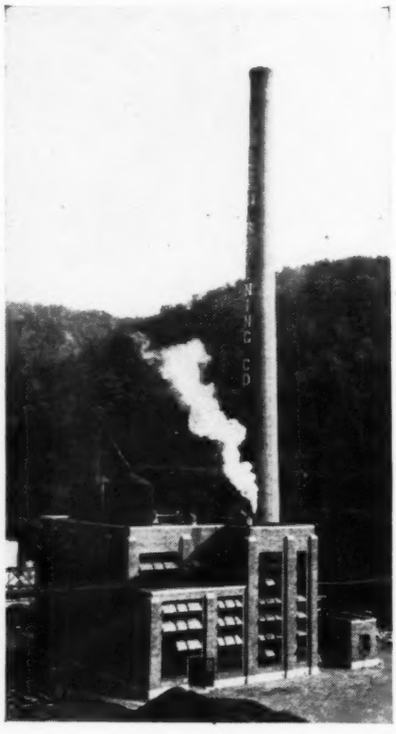
To provide a sufficient supply of steam under a constant pressure and in varying volumes, the company consulted with various boiler manufacturers and stoking concerns to determine what type steam-raising plant was best suited for its needs. Having a limited supply of cracked residuum from its Dubbs cracking plant, and a small volume of fixed gases, the natural fuel seemed to be slack coal. Slack coal is easily available in abundance and relatively cheap in the vicinity of Warren.

Equipment selected for the steam plant were two 580-hp. bent tube boilers, having a working pressure of 250 lb. gauge, and containing 5800 sq. ft. of heating surface on the tubes exposed in the combustion chamber, of radiant heat type, and with water-cooled side and bridge walls.

United Refining Company engineers advanced the idea that the steam generating plant be completely automatic, so far as possible, and that it utilize one of three types of fuel: pulverized coal, cracked residuum, or gas, the latter being natural or fixed gases from the plant residue gas lines. Pulverized coal at the present time is the major fuel used, gas being used only to keep the idle unit hot so that it can be brought to full steaming capacity in the shortest possible time when needed. These two boilers are set in a brick and steel building, with a 225-ft. radial brick and tile stack behind, the breeching being directly behind the east unit so that a third unit can be added without difficulty.

In order that power bills could be kept at a minimum, natural draft was specified for the boilers, with the result that this plant is one of the largest ever built employing pulverized coal as fuel and depending upon natural draft. Each of the two pulverizing units operating in the building in front of the combustion chambers has a capacity of four tons of slack coal an hour. The coal used for the boilers and handled by the pulverizers is unloaded beside the plant into either of two chutes, one in the railroad siding, and the other in a truck road. The coal falls through the unloading equipment and is carried to elevators, hoisted to the two tall fuel bins for working storage, and fed to the pulverizers through automatic feeding devices. The hammer mills in the pulverizers break the slack coal into exceedingly fine particles, which pass through air-swept classifiers that return large particles back to the mills so that nothing will enter the burners that will not flash into flame immediately. Larger pieces will burn more slowly and form slag on the floors of the combustion chambers that cannot be removed until the boiler is taken off the line, and then only with crowbars and picks. These classifiers, hammer mills, and steam-drying units are run by electric motors, each being provided with 100-hp. a-c. units.

The coal slides down from the fuel bin through chutes into the hammer mills without grading, as the coal utilized is quite fine when received. Gravity feed is depended upon, and caking of the coal in the bins and chutes is



United Refining Company's boiler plant at Warren, Pennsylvania, containing two 580-hp. steam boilers, completed early in 1937. Pulverized coal, fuel oil, or gas can be used as fuel

Absolutely Leak-Proof

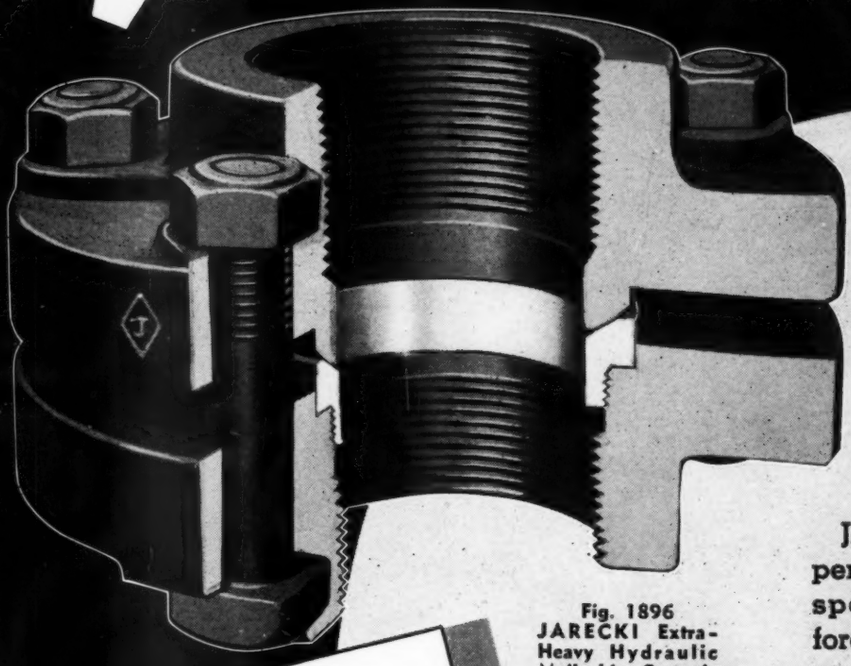


Fig. 1896
JARECKI Extra-Heavy Hydraulic Malleable Ground-Joint Union.

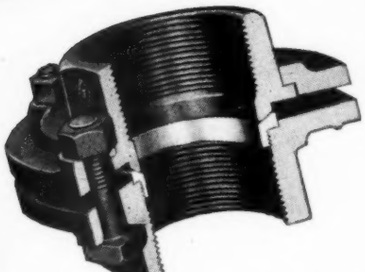


Fig. 1847
JARECKI Three-Piece Standard Malleable Ground-Joint Union.

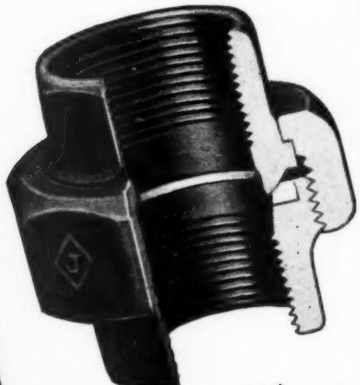


Fig. 101-A
JARECKI Heavy Malleable Ground-Joint Union.

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JARECKI Ground-Joint Unions can be depended on to be absolutely leak-proof. By a special process, the brass seat-rings are forced into place under great pressure, becoming practically one piece with the iron. Seats are accurately fitted, insuring an absolutely tight ball joint. This joint will fit perfectly even though the pipes are not in exact alignment.

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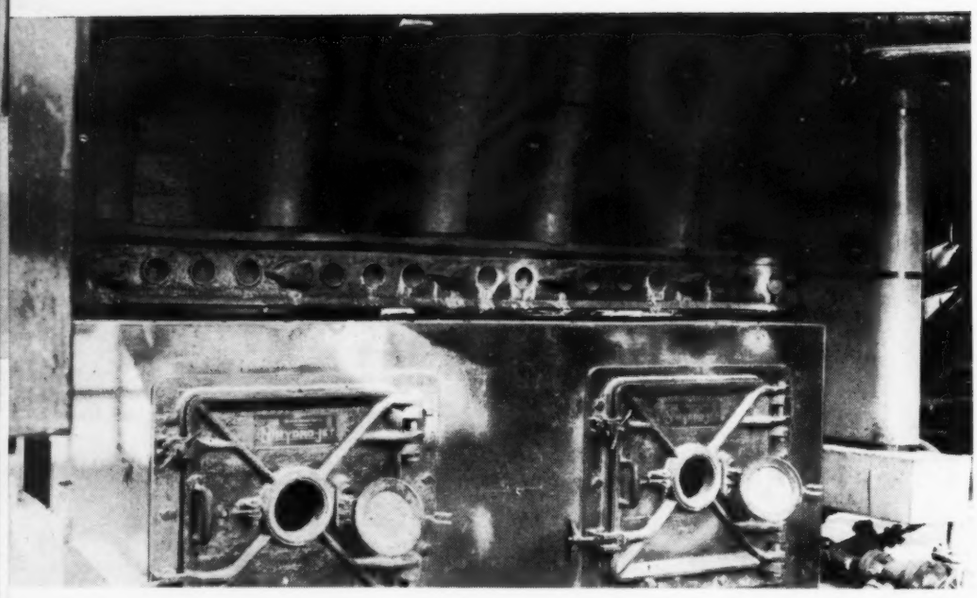
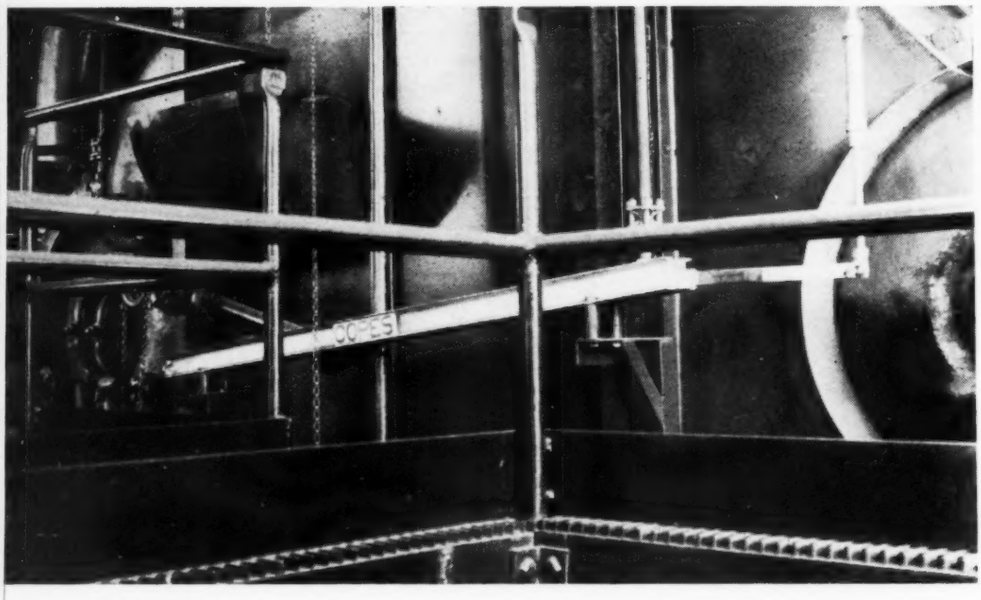
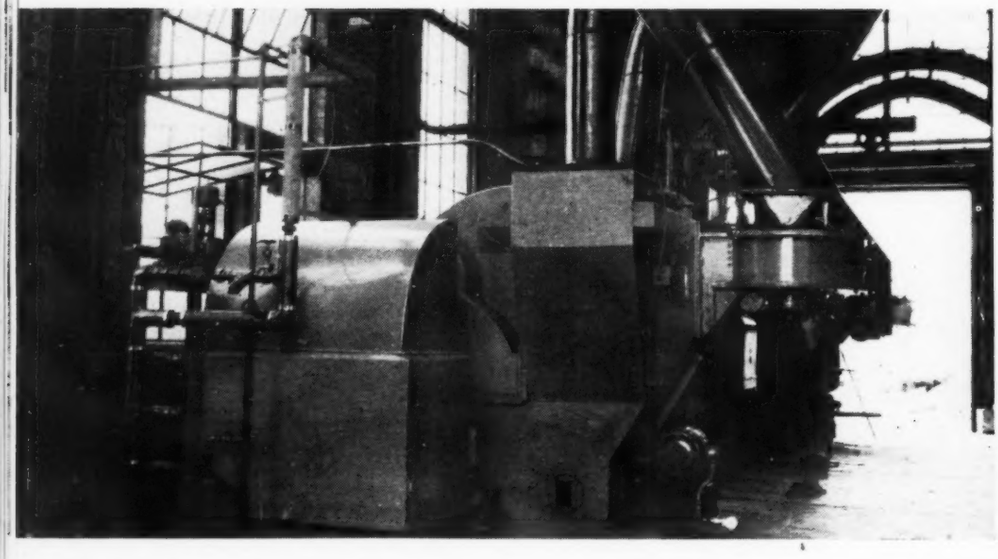


Ash hydrojet on back of boilers



Boiler-feed controller on side of boiler



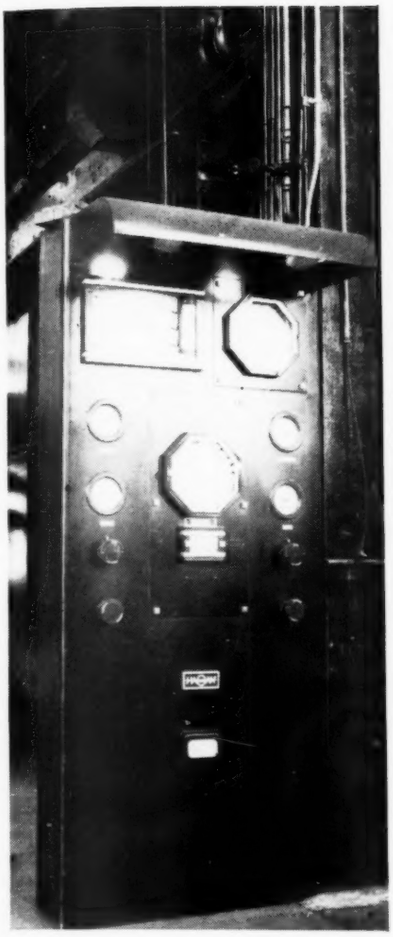
Coal pulverizers

prevented by the fineness of the fuel and the size of the feeder pipes. Coal, after being reduced to the desired fineness, passes through the dryers, in which saturated steam from the boilers is used in radiator-type tubular heaters, so that the moisture content will be normal at all times. Passing in a constant stream through all these units, the coal is fed at the desired rate to the burners, which are set in the front of the boilers along with the oil and gas fixtures. Full automatic controls handle either oil or pulverized coal, one at a time, and one boiler may be fired with coal as the other operates on oil. Each unit has its individual control panel, which is equipped with CO_2 recorder, steam flow recorder, stack and furnace draft indicator recorder, and fully calibrated fuel control instruments. Steam consumption is variable in the plant and when there is demand for more power it comes suddenly as throttles are opened, so the fuel controllers must not lag appreciably.

The furnace floors are flat, constructed of standard fire brick with a sub floor of hollow tile to insure normal cooling by natural draft. The ash resulting from burning coal is handled by a hydrojet removal system installed in the rear of the chambers, and operators blow the fine material back to the devices with steam-operated lances. At the back of each boiler there are several openings through which slice bars and hoes may be inserted to rake the ash into the chutes for removal. Doors of ample size are provided for ease in removing the ash, and small inspection doors are installed in the larger openings so inspection may be made as often as necessary without opening the large doors. Soot is removed from different portions of the units by steam, each boiler being equipped with five soot blowers.

Water for the refinery, as well as

(Continued on page 83)



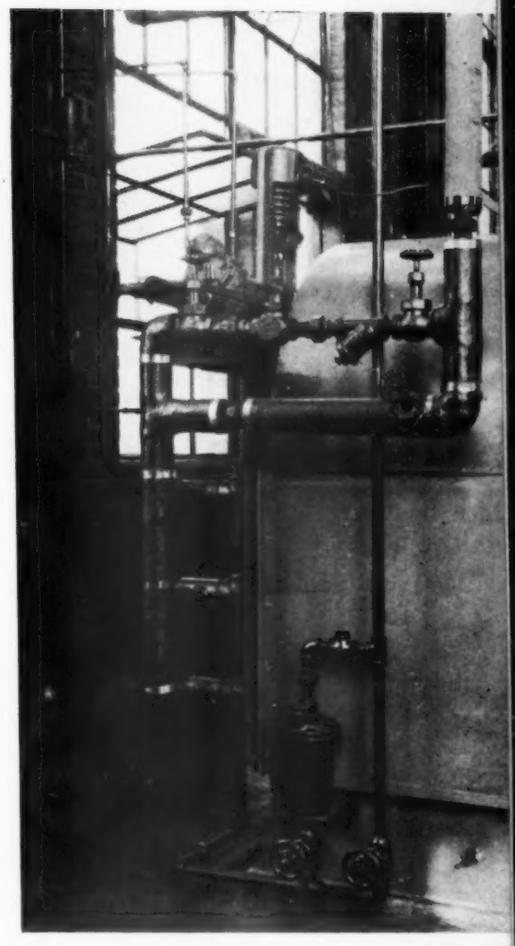
Controls on boiler in United Refining Company's plant, including flow meters

(Continued from page 80)

for the boilers, is obtained from three separate sources: the Allegheny river, a well beside the boiler building, and a well within the plant yard. Either of the three sources is sufficient for all needs of the entire plant, but river water is seldom used for steaming purposes. The well at the boiler building was drilled to water-bearing gravel, which has its water source below the channel of the river, and is produced by an electric-motor-driven deep-well turbine pump. Water for the boilers is pumped to a supply tank and thence to a lime and soda water-conditioning unit, and fed to the boilers slightly hard so as to protect the interior walls of the water tubes. Steam-driven boiler-feed pumps, installed in pairs so as to have a spare ready for operation at all times, pump the water through heaters to the water drum. Each unit has liquid-level equipment for controlling the volume of water pumped to the boiler, and it is conveniently accessible for servicing and adjustment.

The boiler burners will handle either coal or oil, two sets having been placed in the firing doors for this purpose. Should derangement occur within the pulverizers, due, for example, to broken mining tools, such as bits and blasting tools, the oil-burning apparatus instantly can be switched over and the full load carried with the same automatic exactness as if coal were being fired. Provisions have also been made for the installation of full gas-fired burners when and if cheap gas becomes available.

The boiler building is provided with adequate sash to provide a maximum of natural lighting, and safety stairways have been installed throughout the interior so employees and others may pass from the main floor to the roof without danger of falling or being burned. The roof is flat, with the required slope for draining rain and snow water, and the interior is ventilated with several ball-bearing rotary ventilators. The main steam header is carried outward from the building on supporting steel carriers, sufficiently high that trains may pass beneath safely. The header is continued down through the plant parallel to the units, with laterals leading to the points of consumption. Since the installation of these boilers, the entire plant, including all units, has operated much more efficiently, due to an even flow of steam to the pumps and for processing the oils. Construction was done with employees of the United Refining Company, under the able direction of McLean Houston, refinery manager.



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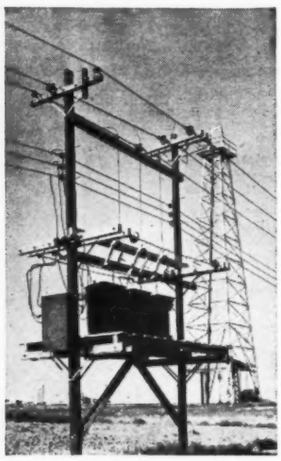

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Bleaching Clay

Part 4

By
RAFAEL FUSSTEIG

Characteristics of Bleaching Clay

As mentioned in the preceding article of this series, the adsorptive power of bleaching clays plays the most important part in the decoloration process of petroleum products; however, in addition to this important property, there are other characteristics that also must be considered in this process. The size of the grains influences to a large degree the decoloration of oils. Bleaching clay for refining petroleum products is placed on the market on the basis of 15 to 30 mesh, 30 to 60 mesh, 60 to 90 mesh, 200 mesh, 500, 1000, and 5000 mesh. The finer the grinding, the better the bleaching power; but, as will be shown later, other factors have to be considered, such as absorption and filter press difficulties.

The production of fine- and coarse-grained material is only possible in the using of natural bleaching clay, but it is impossible to grind the artificially-activated bleaching clays into fine and coarse material. They easily fall into powder. The "Pfirschinger Bleicherdefabrik" in Germany patented a process[1] that makes possible the manufacture of artificially-activated bleaching clay of mechanical solidity. This process consists of the mixing of water-glass before leaching the raw bleaching clay; however, this process could not solve the problem because the coarse grains produced by the method present an insufficient mechanical solidity, and fall into powder after a short time.

These different properties of natural bleaching clay and artificially-activated bleaching clay caused them to be used in different decoloration processes. The natural bleaching clay is used mostly in the percolation processes, while the artificially-activated clays are used in the contact process. The reason for this is that each of the above-mentioned decoloration processes requires quite another kind of bleaching clay. The contact process requires a fine-grained material, while the percolation process necessitates a coarse-grained material. When the grinding of the clay is not fine enough, the bleaching process, by means of the contact process, will not be completely executed, because the coarser grains fall very easy on the bottom of the agitator, thus remaining unattacked. In other words, the finer the grinding the greater the adsorption surface, and with it the activity. Although it is true that fine grinding improves the decoloration process on account of the greater surface exposed, it also is true that a limit of fineness is easily reached beyond which the difficulties arising from slow filtration and from retention of oil become of greater moment than improvement of bleaching power. Exceeding the limit leads to a bad filtration of bleaching clay, and gives, besides a great loss of time, a residue very rich in oil instead of a solid filter-press cake, which increases considerably the loss of oil. Therefore, it is very necessary to examine the fineness of a bleaching clay before using it for decoloration. This examination is very easily carried out. A certain quantity of bleaching clay is weighed out, and then sifted through a sieve of the desired mesh number. For example, assume we observe the quantity of residue that will remain on sieves of 500, 1000, and 5000 mesh when the clay is passed through them. By weighing each of these residues separately, it is easy to calculate the percentage of the grains, thus permitting the determination of the state of fineness. Of course, these results must be compared with a bleaching clay whose fineness is known to be sufficient in the decoloration process.

As mentioned, the decoloration of petroleum products by means of the percolation process requires natural bleaching clay, such as Fuller's earth. The coarse-grained bleaching clay is important for economy and for obtaining the best results. For this purpose, two sorts of grinding are used: a coarse-grained sort that should not leave a residue on a 15- to 30-mesh sieve, and the fine-grained sort, which should not leave a residue on a 60- to 90-mesh sieve. These grains must be very solid and have no tendency to fall into powder during the percolation process. When the grains fall into powder, the percolator will be stopped, and the filtration can not be continued. It has been shown that for given weights of bleaching clays one of 60- to 90-mesh has an efficiency of about 10 to 15 percent greater than one of 30- to 60-mesh, and the latter about 20 percent greater than one of 15- to 30-mesh. In addition to the sort of grains, the percolation must be subject to the following conditions:

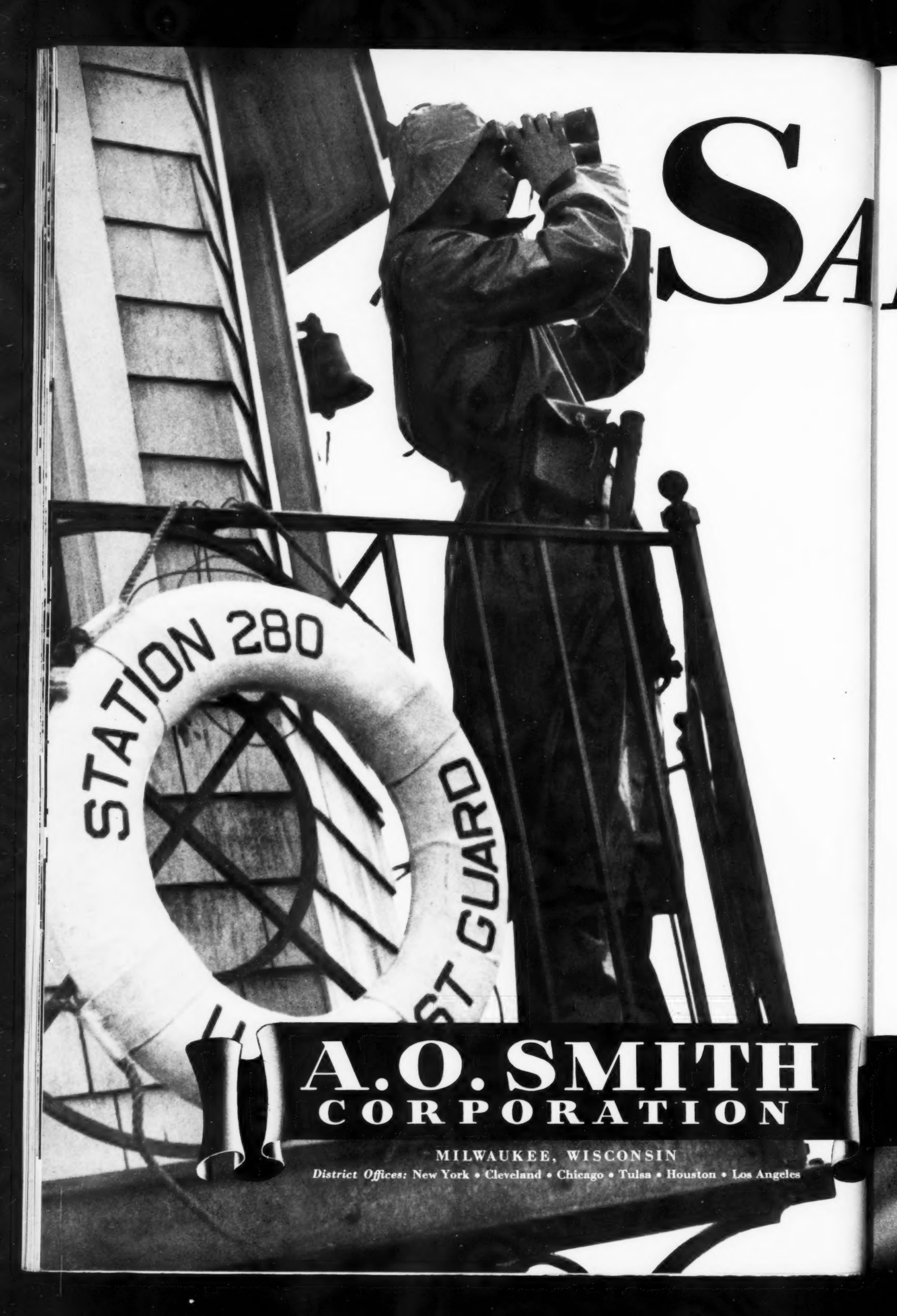
1. The longer the column, the greater the time of contact and the greater the decolorizing power of the bleaching clay.
2. The coarser the earth, the more rapid the flow and the less the decolorizing power of the bleaching clay.
3. The higher the temperature, the faster the flow and the less the decolorizing power of the bleaching clay.

As mentioned, the filtration power plays a very important part in both the percolation process and the contact process, because it influences the clearness of the oil, the time of filtration, and the content of oil in the bleaching clay residue. Bleaching clay of a high volume is able to retain more oil, in the event it is impermeable. This is the reason that such a clay forms an impermeable layer, resulting in the filtration being interrupted early. When using the contact process, the filter-presses give, instead of a solid cake, a soft cake rich in oil. When using the percolation process, the bleaching clay in the column must be extracted often with gasoline.

To determine the filtration power of a bleaching clay several samples of bleaching clay from different deposits were dried and ground. One portion of a sample was ground in a coffee mill so arranged that about half of the material would pass through a 100-mesh sieve, the residue being returned to the coffee mill and reground, and so on until the whole had been reduced to 100 mesh. On examining this material with sieves it was found that a considerable portion of the product passed a 200-mesh sieve, but to determine this proportion with accuracy was not easy. A second portion of the same sample was ground in an agate mortar until the whole passed a 100-mesh sieve, and as was to be expected a larger portion passed a 200-mesh sieve than was the case in the first instance, but the difference could not be accurately determined. When the two portions were subjected to filtration tests it was at once apparent that there was a vast difference in them.

Using the coffee-mill ground material, filtration in a Buchner funnel was easy; the oil remaining was readily drawn out of the pores by suction and could have been further removed by blowing steam through the funnel, as is done in the filter press. With the mortar-ground bleaching clay the period of filtration was long and ted-

(Continued on page 88)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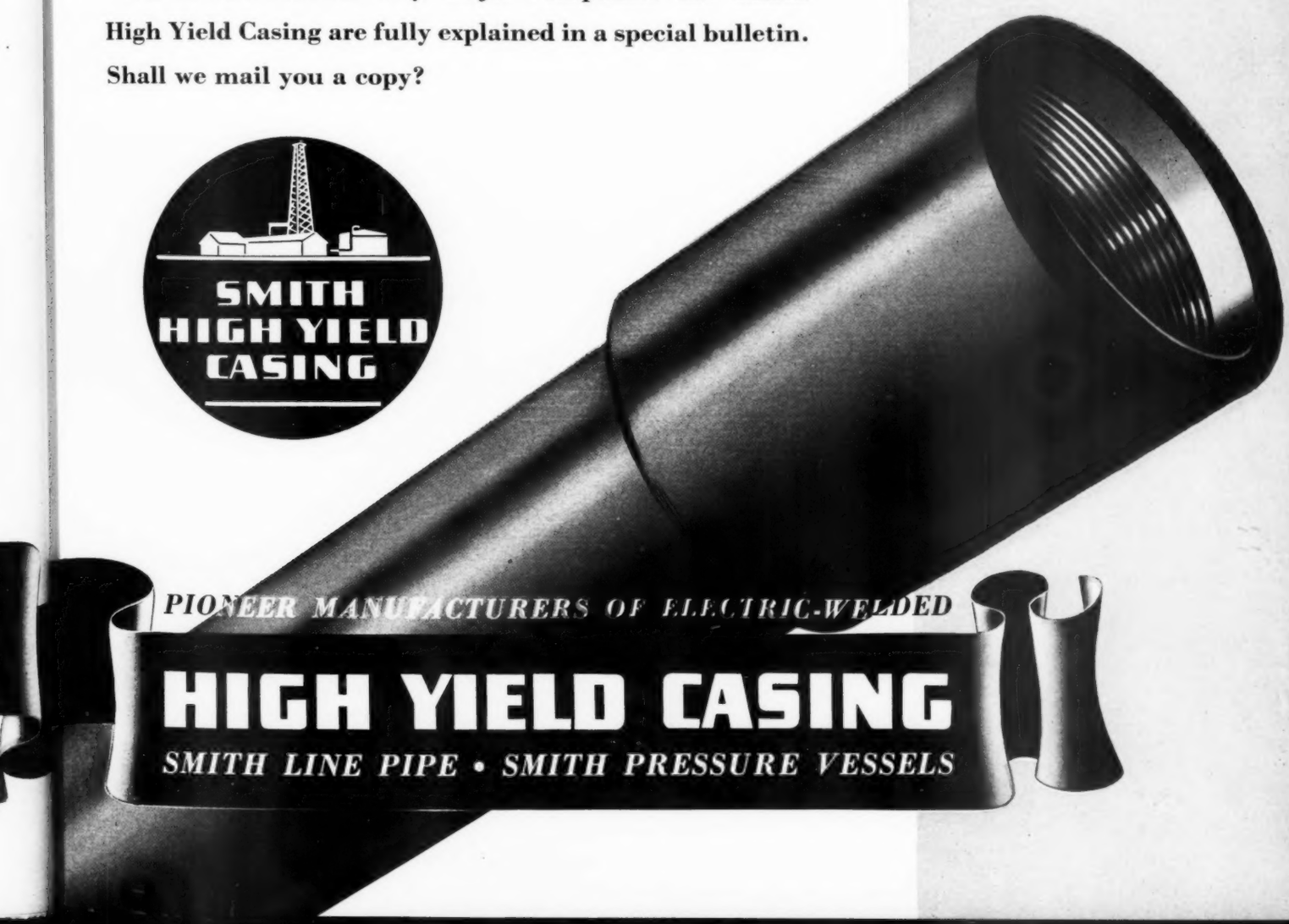

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(Continued from page 85)

ious and the remainder of the oil could not be satisfactorily extracted from the sample, which remained as thick, oily mud. Under the microscope it easily could be observed that the mortar-ground portion contained a very much larger portion of very fine material. A number of tests were performed in a similar manner by Parsons[2] on different samples, the results of which are as follows:

Filtration Tests of Samples of Fuller's Earth

Origin of the earth	*Method of grinding*	*Time of filtration. Minutes*	*Conditions of residue*
Summerville, Texas	In coffee mill	5.5	mealy
	In agate mortar	10.5	rather oily
English earth	In coffee mill	5.0	quite dry
	In agate mortar	10.0	fairly dry
Pikes Peak, Georgia	In coffee mill	4.5	quite dry
	In agate mortar	45.0	very oily
Midway, Florida	In coffee mill	5.0	quite dry
	In agate mortar	30.0	very oily
Klondike	In coffee mill	12.0	fairly dry
	In agate mortar	29.0	very oily

The degree of absorption also is a very important factor in the examination of the bleaching clays. The more oil is absorbed by a clay, the more unfavorable is this clay for the decolorizing process. In general, the finely-ground bleaching clays absorb more oil than the coarsely-ground. According to Loeb[3] the degree of absorption is the function of the volume of the clay. The lighter, that is to say, the more voluminous the bleaching clay is, the greater the degree of absorption. According to this opinion, the specific heavier bleaching clays have a lesser degree of absorption.

In order to determine the degree of absorption of a given clay, the following method, which is proposed by the German Pfirschinger Bleicherdefabrik, can be used:

An empty glass with a rod glass is first weighed, and then 100 grams of a bleaching clay are weighed in it. Oil is then added to this clay, slowly drop by drop, until the mixed mass is of uniform consistency and shows neither dry clay nor liquid oil. The glass with its contents is then weighed, and the increase in weight shows the degree of absorption of oil per 100 grams of bleaching clay. In event viscous oils or paraffin waxes are considered higher temperatures must be used. According to this method, the following results have been found:

100 parts filter charcoal absorb	250 parts oil
100 parts residue of potassium ferrocyanide absorb	150 parts oil
100 parts hydrosilicate absorb	110 parts oil
100 parts Fuller's earth I absorb	64 parts oil
100 parts Fuller's earth II absorb	50 parts oil
100 parts Fuller's earth III absorb	45 parts oil
100 parts Fuller's earth IV absorb	42 parts oil
100 parts of artificially-activated I earth absorb	35 parts oil
100 parts of artificially-activated II earth absorb	32 parts oil
100 parts of artificially-activated III earth absorb	25 parts oil
100 parts of artificially-activated IV earth absorb	18 parts oil

As seen from the foregoing table, the artificially-activated bleaching clays have a lower degree of absorption for oils than the natural bleaching clays; but before entering into this matter it is desirable to discuss other characteristics of bleaching clays. The content of moisture also plays a very important part in the quality of bleaching clays, i. e., when a moisture exceeds a certain limit the decoloration power will be reduced.

In the southern countries it frequently happens that bleaching clays lose their activity within a short time. The reason for this is the great humidity of these countries. Especially is the artificially-activated earth very susceptible to moisture and it loses its activity quickly under the influence of water. Davidson[4] has stated that the moist bleaching clay has not the same efficiency as the dry. Eckert[5] has found that a moist bleaching clay, after treating with sulphuric acid, has a greater deacidification effect than dry bleaching clay. Therefore, moist bleaching clay first must be dehydrated before using it in the bleaching process; but a great difference in dehydration behavior between the natural bleaching clays and the artificially-activated bleaching clays has been found to exist.

Natural bleaching clay easily can be dehydrated by corresponding temperatures and their original bleaching power restored. The artificially-activated bleaching clays show quite other characteristics; they lose their bleaching power entirely when submitted to dehydration. The reason for this is the complete destruction of the microscopic and ultra-microscopic channels.

Of course, the microscopic channels of natural bleaching clays are much stronger than those of the artificially-activated clays because their interior walls are covered by a layer of different salts, this layer giving them a high resistance to high temperatures. The artificially-activated bleaching clays present a structure of very thin and weak channels because the leaching process of acids on the rough material has extracted the layer of salts from the interior of microscopic and ultra-microscopic channels.

It is true that the leaching process has increased to a very great extent the adsorptive power of the channels but it is also true that this process weakened very much the microscopic structure of bleaching clays. It is thus seen that the more moisture an artificially-activated bleaching clay contains the more difficult is its dehydration. When the artificially-activated bleaching clay contains a proportionally small amount of moisture, it can be dried by the application of normal steam heat. In other words, the dehydration of artificially-activated clays can not exceed the temperature of 100 deg. centigrade.

A certain amount of moisture should remain in the above-mentioned bleaching clay. The writer's investigations have established that when storing an artificially-activated clay for a long period of time in a very dry and warm room, its adsorption power will decrease gradually. The reason for this is that the walls of the dry microscopic channels are very brittle and tend to crumble. It is necessary therefore to permit such a clay to absorb an admissible amount of moisture because this moisture strengthens the walls of the microscopic channels. It is seen that artificially-activated clays that are too dry must be submitted several hours to the influence of humid atmosphere. Of course, if such a clay is stored for very long in a humid room, disintegration destroys the microscopic channels. In this case the influence of atmosphere is unable to increase the bleaching power. As mentioned, the dehydration of natural bleaching clays increases its bleaching power; however, a temperature of 400 deg. cent. should not be exceeded. To exceed this temperature is harmful to the bleaching clay. When submitting the natural bleaching clay to a temperature of 800 deg. cent., it becomes entirely inactive, i. e., its adsorptive power disappears. The reason for this is that the microscopic structure becomes very brittle at 800 deg. cent. and crumbles.

Nevertheless, the artificially-activated bleaching clays are preferred to the natural clays. The reason for this is the considerably higher adsorptive power. Because of the development of the microscopic structure such bleach-

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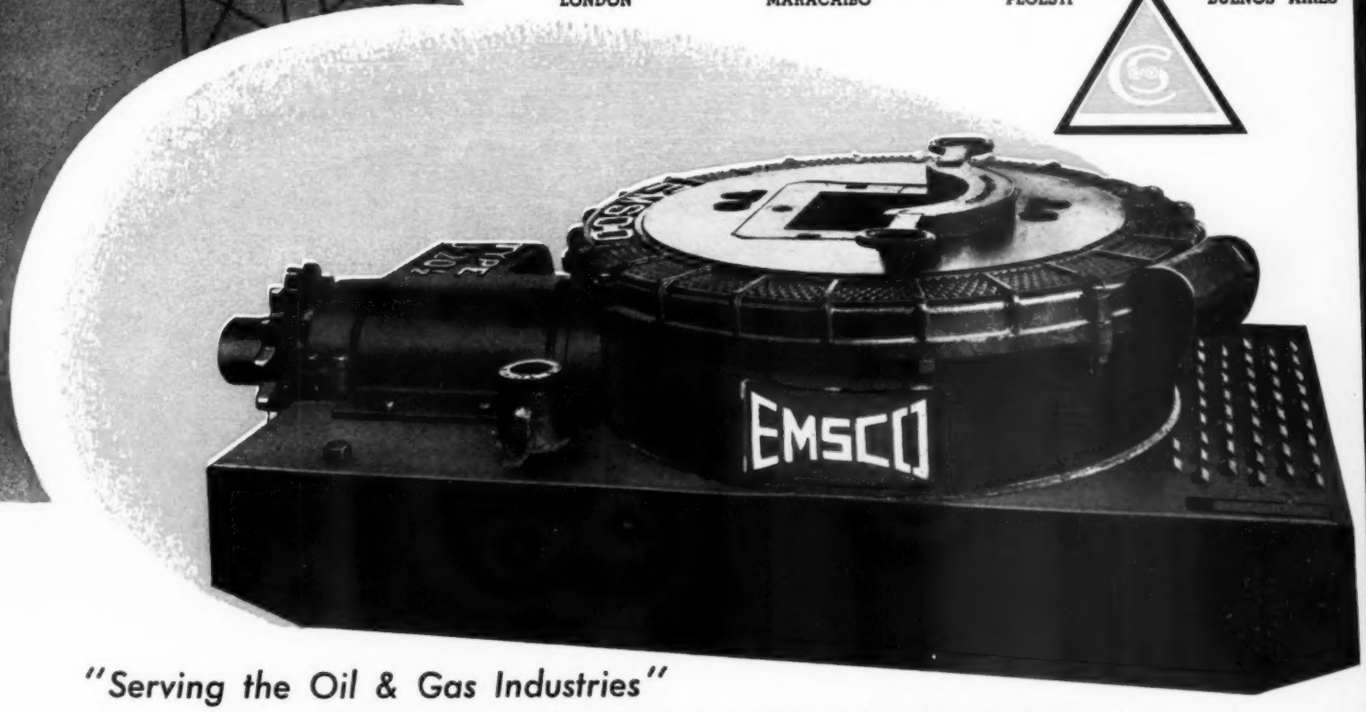

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ing clay also has a greater permeability and filtration capacity. The increase of the adsorptive power causes an easy adsorption of the higher molecular unsaturated hydrocarbons; these resin-like compounds do not allow the lower molecular hydrocarbons to be adsorbed. This is the reason that the artificially-activated clays have a very small oil absorption capacity; that is to say, the clay gives a filter press coke poor in oil.

The artificially-activated clays, however, have a very important disadvantage. They contain a very small amount of acid that acts harmfully on the oils. As mentioned, clays are activated by means of a leaching process with acids. Following the leaching process, the acids are carefully washed out, but no washing is able to remove the traces of acid; therefore, this sort of clay can not be used in bleaching where the traces of acids and their salts could hurt the oil.

All natural clays that have been found valuable for bleaching purposes show a distinct so-called acid reaction. If a sample is tested with neutral litmus paper, the paper will turn red; if the clay is suspended in water and phenolphtalein is added, a quantity of alkali, which varies widely with different clays, can be added before the red color appears. This property is no indication of true acidity, for the natural clay contains no acid. The same power that enables the clay to adsorb basic colors enables it to adsorb true bases also, and to prevent their reaction becoming evident until the adsorptive power of the clay has been satisfied.

The degree of "acidity" or adsorptive power for bases in solution in water is no definite criterion of the power of the clay for adsorbing bases or colors from solution in oil. Accordingly, the bleaching power of natural bleaching clays for oils is by no means proportional to the ability of the clays to remove bases in solution in water. The degree of "acidity", however, is directly proportional to the power that most natural bleaching clays have of removing basic colors from solution in water. All these clays adsorb basic colors in solution in oil or in water. Their commercial value, however, depends upon their capacity for removing these colors from solution in oil, which is by no means the same as removing these colors from water.

Specific volume and specific gravity of bleaching clays are of very great importance, as they determine the size of measure to use in adding the clay to the oil. The specific volume depends in a large measure upon the fineness. The more voluminous the clay is, the lighter is its specific gravity. The volume occupied by a definite weight of bleaching clays is of importance as affecting the number of times a filter press must be opened for a given quantity of clay; therefore, the above-mentioned factors are of great importance. The specific volume of artificially-activated clays is greater than that of natural clays; that is, the specific gravity of the former is less than that of the latter. The reason for this is the increase of microscopic channels in the artificially-activated clays. Accordingly, the range of specific gravity of natural bleaching clays is between 2.3 and 2.6, while that of artificially-activated clays is between 1.7 and 2.1.

The further reason for this great difference is that the natural clays contain a considerable amount of crystalloids, such as quartz, and particles of feldspath, these substances increasing specific gravity. The crystalloid matter only wets the oil on the surface during the decoloration process, while the colloidal silicates of the bleaching clay sucks the higher molecular unsaturated compounds of the oil into the interior of the channels. It also must be noted here that the adsorption of each sort of oil impurity depends upon the size of the microscopic channels. This leads to the fact that a given bleaching clay, which decolorizes favorably a given oil, may be unsuitable for bleaching another sort of oil. That is the reason that many refiners prefer a mixture of several bleaching clays. Many investigators have established that with the aid of the bleaching clay the bleaching process can adsorb all coloring matter except red; only chemical agents are able to remove red coloring matter from the oil.

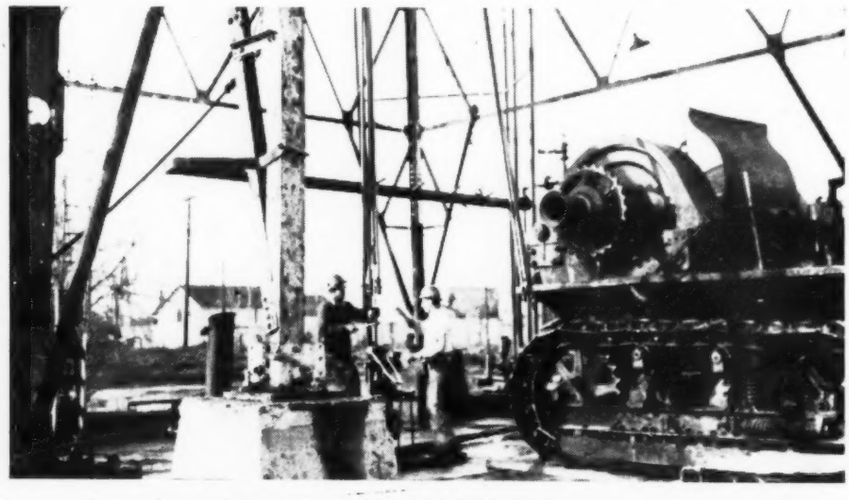
LITERATURE CITED

[1]D. R. P. 51. 635.
[2]Bulletin 71, Dep. Int. Bureau of Mines, 1913.
[3]Seifensiederzeitung 1925, p. 1024.
[4]Seifensiederzeitung 1928, p. 648.
[5]Ang. Chemie 1925. 887.

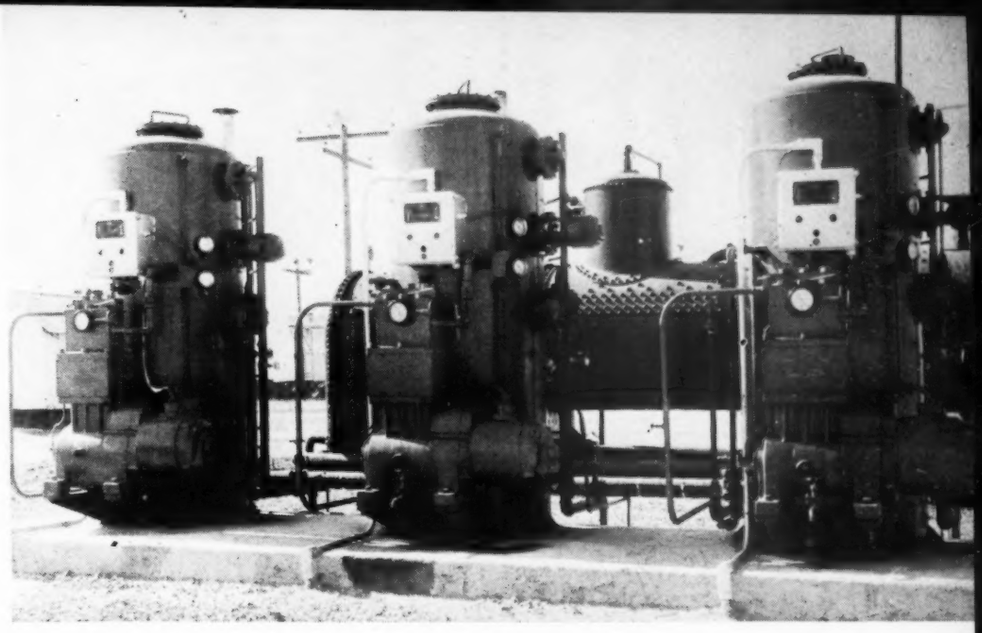
Simple Device Facilitates Well-Servicing Operations

THE Richfield Oil Company uses a simple, inexpensive rack that prevents sucker rods from hanging directly over the derrick floor; also it may be used to loop loose ends of rod and tubing lines to keep them out of dirt and sand. This device, a "tie-back," is made by taking a short joint of 2-in. pipe, flattened at one end and shaped to fit a leg of the derrick. Hook bolts are used when the "tie-back" is applied to angle steel derrick legs.

Holes are drilled in the unflattened part of the pipe at desired intervals with dowel pins inserted in the holes so the rods may be hung back out of the way of the well-servicing crew. It is attached to one leg of the derrick with the clamps and at such a height as may be convenient, yet sufficiently high to prevent even a tall man from striking his head when walking beneath it. The cost of making this simple device obviously is nominal, and crews who have used it say that it could not be dispensed with when rods are being pulled.



Inexpensive sucker rod tie-back used by Richfield Oil Company in the Montebello field, California, on wells serviced by that company



Three power units producing four wells by the hydraulic pumping method in the Mountain View field, California

By
S. A. WALLACE

A discussion of the application of recently developed pumping methods and their efficiency

Hydraulic and Plunger-Lift Pumping in California

APPROXIMATELY 93 percent of the producing wells in California are on the pump. As reported by J. R. Pemberton, umpire for the Central Committee of California Oil Producers, there are 17,562 wells in the state capable of producing oil in commercial quantities. Of this number 13,093 are actually producing at the present time and 4469 are shut in. Of the active producing wells, 564 are flowing naturally, 322 are on gas-lift, and 12,207 are pumping. Data on the number of flowing, gas-lift, and pumping wells, together with the production from each class, are shown in Table 1. These figures are compared with similar ones of a year ago and it can be seen that, although the number of wells in each class has increased during the year, the percentage has remained about the same. Average production by each method has shown a slight increase; and probably reflects increased allowables. The number of wells on gas-lift has increased 24 percent, an increase considerably greater than the increases in the number of flowing wells and those on the pump, which are four percent and eight percent, respectively.

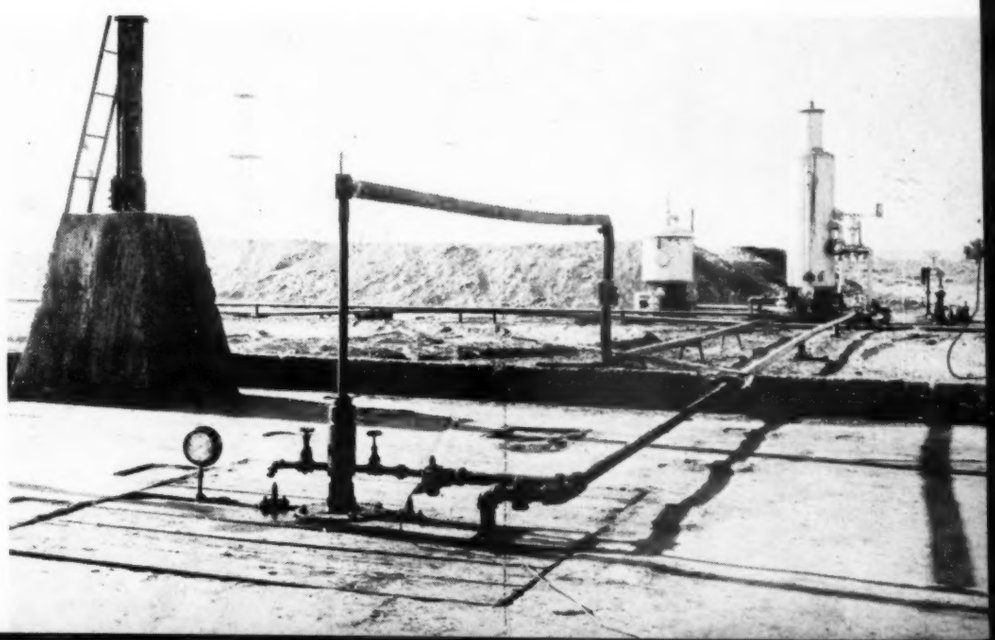
Gas-lift, though not a pumping operation, does utilize an artificial means of producing oil. It is a recognized production method and some consider the use of newly-developed valves and other equipment run into a hole (to provide automatic intermittent flow or to procure other results) as a form of gas-lift pumping technique. This discussion is confined to the results obtained by the hydraulic pump and the plunger lift; the injection of gas frequently is necessary with the latter type of equipment. In the data given in Table 1 the hydraulic pump and the plunger lift are included with the pumping wells but the number of such installations will seem rather small when compared with the great number of wells on the pump. Many of the pumping wells, however, are very old and very small producers, the average for the entire state being 34 bbl. daily; yet a pumping production as high as 600 bbl. daily has been obtained with pumping methods under discussion and as much as 800 bbl. of mixture of gas and oil now is being produced from one well.

The construction and operation of the hydraulic pump has been fully described in various articles during the past few years.[1]

Briefly, the hydraulic pumping equipment consists of a pump-and-engine unit that is lowered into the well and a hydraulic-power unit placed at the surface. The down-hole unit comprises a double-acting reciprocating plunger pump direct-connected to and operated by a fluid engine. This unit is inserted into the production string of tubing, which is provided with a gas anchor at its lower end and with a shoe in the bottom of the gas anchor. The pumping equipment is run-in on a macaroni string called the pressure tubing and seats in the shoe. The fluid engine actuating the pump is driven

(Continued on page 96)

[1]A comprehensive treatment of this pump was presented at the Los Angeles meeting of the A.P.I., November 13, 1935, in a paper entitled "Hydraulic Power Applied to Oil Well Pumping," by C. J. Coberly.



Flow of power-oil into well, being produced with a group by hydraulic pumping, is controlled by the metering valve seen on the riser

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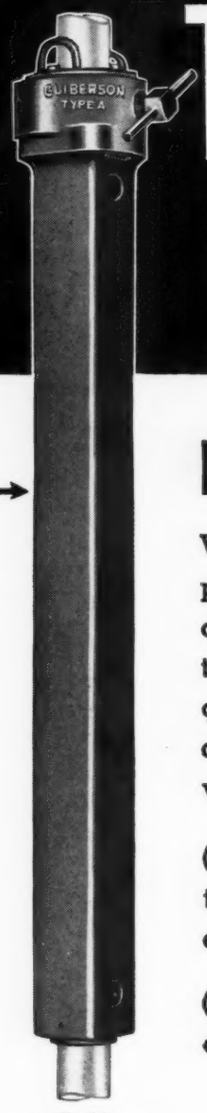

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cuttings are carried to surface quicker due to increase in flow rate of oil and gas.

(5.) Drilling time and money saved because more hole per bit can be made due to jetting action of oil and gas through and across bit resulting in rapid removal of cuttings.

(6). Less expensive, as all GUIBERSON Equipment is sold outright thus saving operator costly rental and service charges.

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(8). For cleaning out wells after shooting with nitroglycerine better wells are made in one-tenth the time with the use of the same GUIBERSON method and the same GUIBERSON equipment.

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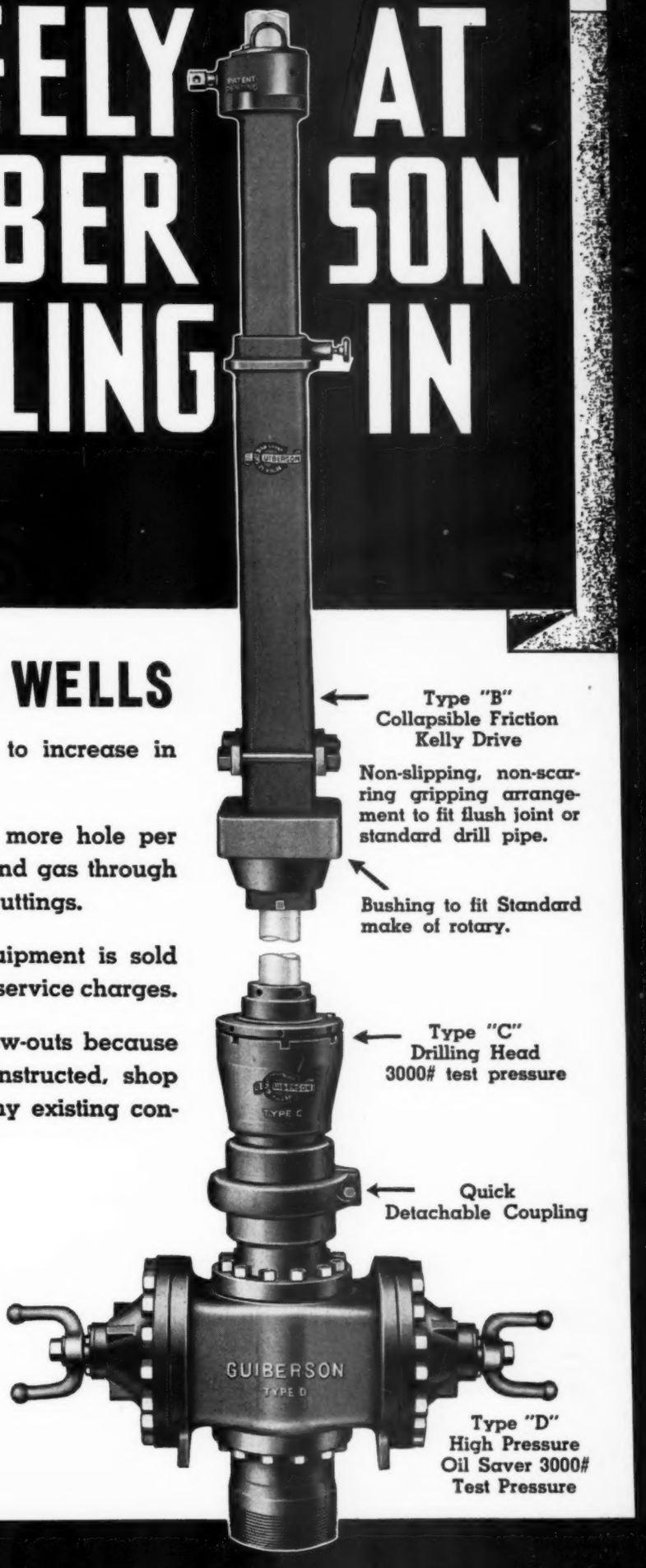

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(Continued from page 93)

by clean, filtered oil forced down the pressure tubing, the exhaust being carried back to the surface through the annular space between the pressure and production tubings with the oil produced by the well.

The hydraulic-power unit at the surface supplies under pressure the oil that operates the fluid engine. Included in this unit is a combined motor and triplex pump, a filter system, and all necessary equipment for gas separation, heating of the oil, controlling back-pressure, providing clean oil, backwashing the filter, and time-controlling the filter motor. The compact design of this unit with all its facilities inclosed in or attached to one shell is shown in accompanying illustrations.

Until very recently, all installations of the hydraulic pump in California have used electric motors for supplying the clean oil under pressure to the fluid engine in the well. The pumps most recently installed in the Kettleman Hills field have been equipped with 6-cylinder, 60-hp. gas engines, gas in that field being available for any purpose. As there are many other fields in which an ample supply of gas is available, the operation of the gas-powered units is being carefully observed. In addition to savings in operating costs the use of the gas engine probably makes the installation a little more flexible.

In producing a well with the hydraulic pump, the double-acting reciprocating plunger pump must be set below the fluid level. The greatest depth from which a well has been pumped by the hydraulic method was that encountered in a well in the Seal Beach field whose fluid level was 8200 feet.

The greatest depth now being pumped by the hydraulic pump is that encountered in a well at Santa Fe Springs where the fluid level is approximately 8100 feet. This well is producing 120 bbl. daily and is pumping that volume steadily. Another well in the same field has been producing 50 bbl. daily from a depth of 7600 ft. for the last two years without pulling.

Although the efficiency is higher in the deeper wells, because the motor loss and other conditions pertaining to the operation of the equipment change little with an increase in depth, the hydraulic pump is quite efficient even in shallow wells. At the present time wells as shallow as 2000 ft. are being produced by the hydraulic pump.

One or more units may be employed to produce several wells, the size and number of units being governed by the size of the wells and other factors. On one lease at Mountain View, three units are used to produce four wells. The wells are approximately 5500 ft. in depth and they produce in different volume. The power-oil line to three of the wells is equipped with a metering valve and the power-oil into the pressure tubing is regulated by this valve. The fourth well is not so equipped but takes the power-oil remaining after the other three wells are supplied. The excess volume of power-oil is not just an uncontrolled amount, but is governed by the total volume put out by the three power units.

The use of two power units on one well to handle a large volume of oil is not new. One well at Kettleman Hills in which the fluid level is 7000 ft. in an 8000-ft. hole is equipped with two large units and has been produced in this manner for about two years. Although the total volume of pipeline oil is 450 bbl. daily, the actual amount of fluid—consisting of a mixture of oil and gas—is 800 bbl. daily at the pump. This fluid has a temperature of 250 deg. fahr. at the pump and the oil a gravity of 37 deg. A.P.I. after the gas has been taken off.

The water content of the power-oil supplied by the power unit generally is kept between 0.2 and 0.3 percent, though in several California operations, where heavy oil is being pumped, such as at Ventura and Mountain View, a water content as high as three percent frequently is allowed. The heaviest oil that has yet been pumped in California by the hydraulic pump is about 19 or 20 deg. A.P.I., though there seems to be no reason why oil of any gravity cannot be handled effectively.

From field tests conducted on wells where the operating conditions were more or less average and the range in depth was from 2000 ft. to 7000 ft., the pressures required varied from 1000 to 2800 lb. per sq. inch. The tests were made both in straight and crooked holes, in wells the production from which ranged from clean oil to oil that cut 47 percent, in one well with bad wax, and in another well under sandy and corrosive conditions. The efficiency of the surface unit was 74 to 79, pump volumetric efficiency 83 to practically 100, and the over-all efficiency (based on hydraulic output/electrical input) 58 to 67 percent.

The automatic control of the hydraulic type of pump aims to give either constant pump displacement or constant fluid level with variable displacement. This control can be utilized to obtain orderly withdrawal of fluid from a field, to hold bottom-hole pressures uniform, or to control the shape of the pressure contours.

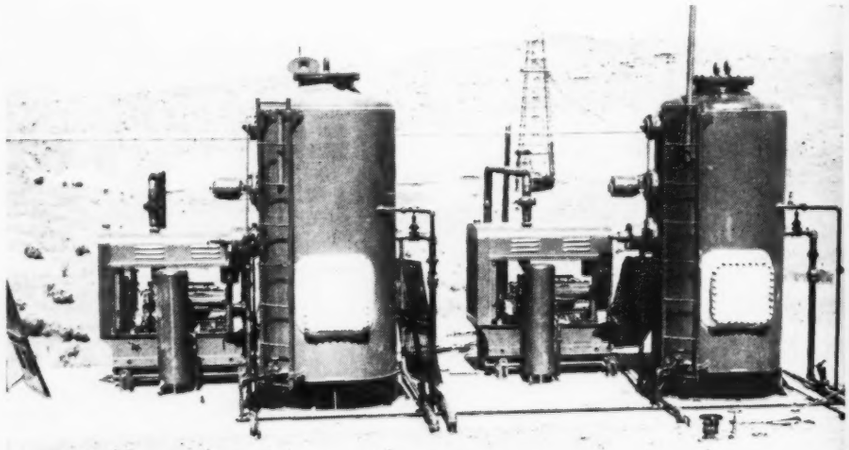
The plunger-lift is an entirely dif-

TABLE I

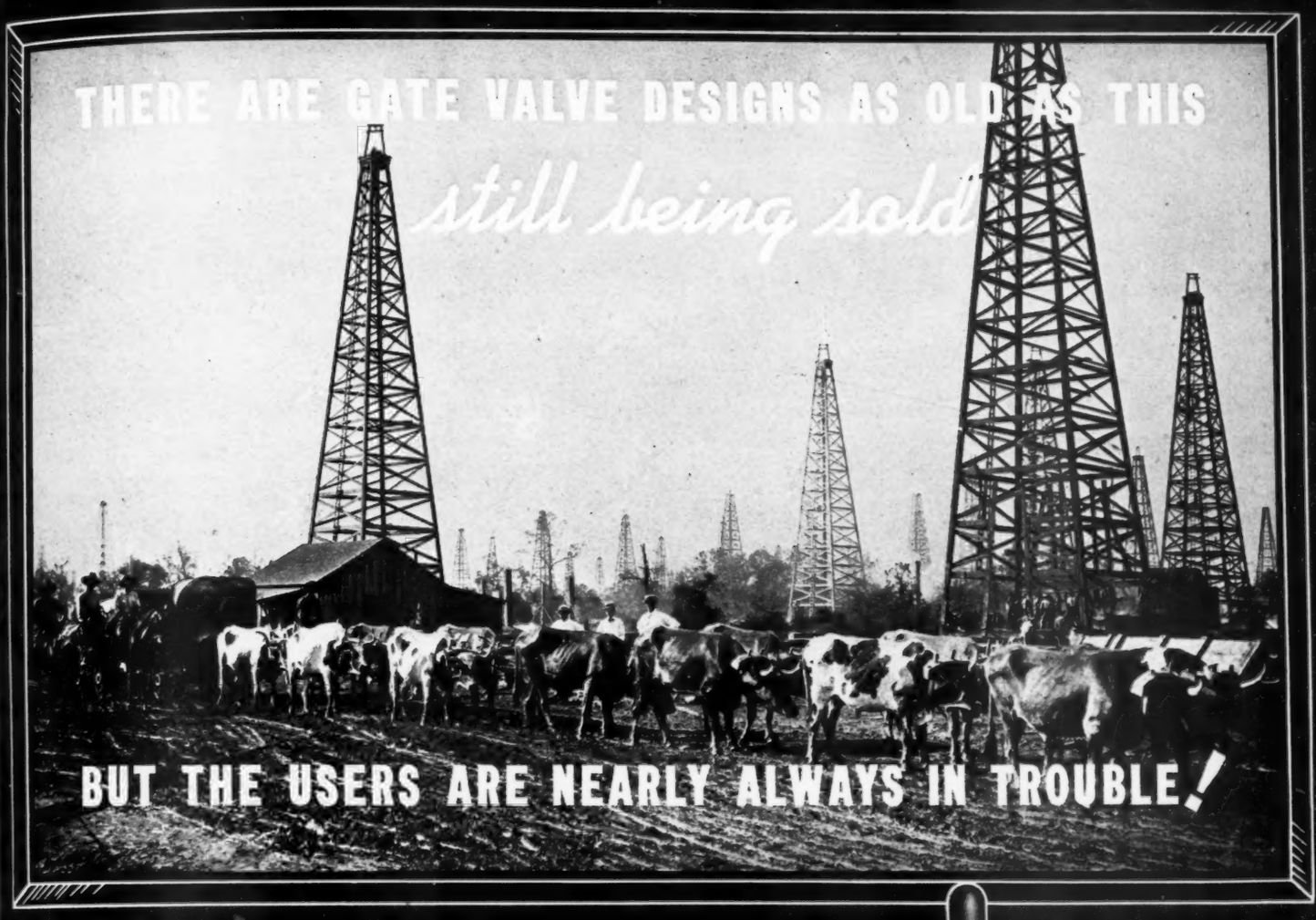
PRODUCING WELLS IN CALIFORNIA[a]

	Present Daily Production (bbl.)	No. of Wells Actively Producing		Average Daily Production per well (bbl.)		Percentage of Each Class			
						No. of Wells		Daily Production	
		Now	Year Ago	Now	Year Ago	Now	Year Ago	Now	Year Ago
Flowing	169,148	564	541	300	296	4.3	4.5	25.6	28.5
Gas-Lift	82,314	322	260	255	223	2.5	2.0	12.4	10.0
Pumping	410,224	12,207	11,345	34	30	93 2	93.5	62.0	61.5
Total	661,686	13,093	12,146	51	46				

(a) Compiled from reports by J. R. Pemberton, Umpire, State of California.



In this Kettleman Hills field installation the power-oil is pumped with 6-cylinder 60-hp. gas engines connected to a 4-in. pump with a V-belt drive



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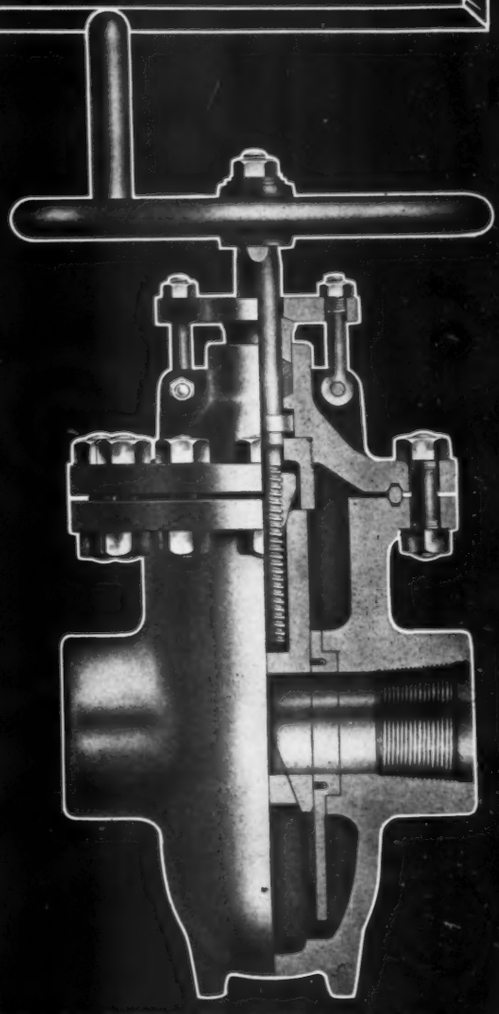

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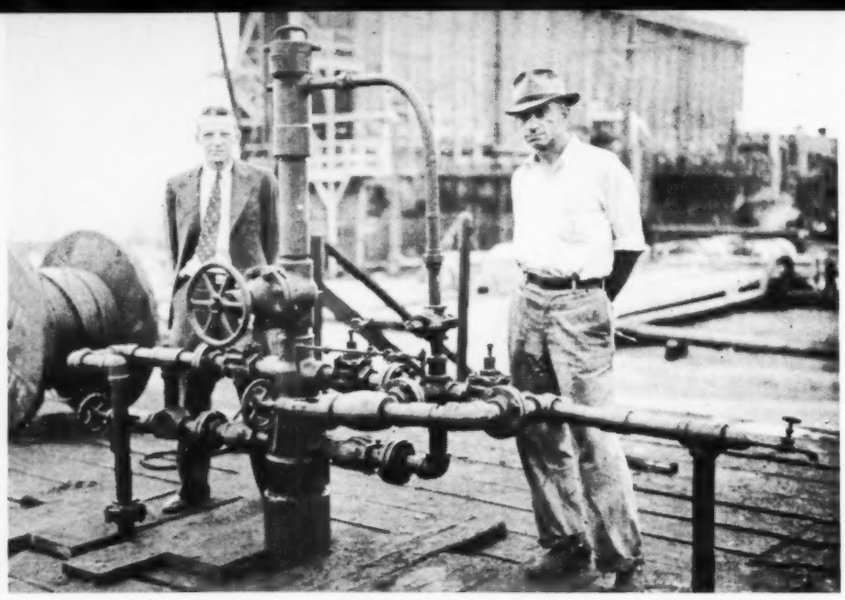


Surface connections of a well being produced by plunger-lift in the Dominguez field

ferent method of pumping from that just described. The lifting force here is provided by gas but the oil itself is raised to the surface by a plunger. This plunger travels the entire distance from the bottom to the top of the tubing and back again to the bottom at each stroke. It does not, however, lift a column of fluid extending the full length of the tubing but produces the oil in short heads that usually are less than 300 feet in length.

In addition to the plunger, the equipment includes a string of special, smooth-bore tubing supported from the flow head at the surface. This head is adapted to receive the slug of oil lifted by the plunger and direct it to the flow lines. A foot-piece at the bottom of the tubing stops the plunger and closes a valve in the plunger at the end of the down stroke. The plunger itself fits rather loosely in the tubing and, after having been lifted by the gas, falls by gravity to the bottom of the tubing.

In some plunger-lift operations extraneous gas has to be introduced into the well. In many fields this gas is readily available from other lease operations but in some it has to be purchased from an outside source. This latter course is followed in a well in a Los Angeles Basin field where gas at a pressure of 90 lb. per sq. in. is being taken from a public service line. The total depth of this well is slightly more than 4000 ft. and the tubing is set six ft. off bottom. It is produced through 3-in. tubing and the production averages a little more than 225 bbl. daily, which is an increase of approximately 60 bbl. daily over the well's production before being put on plunger-lift. The casing pressure is 89 lb. per sq. in. and the maximum tubing pressure 50 lb. per sq. inch. The gas input totals approximately 80,000 cu. ft. daily and the output 350,000 cu. ft. daily.

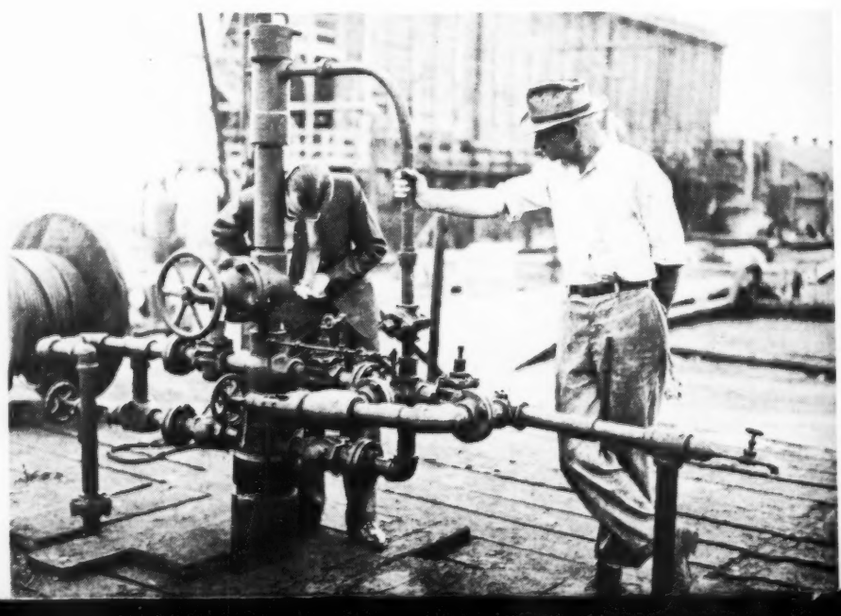
Gas required for lifting amounts to but little more than 380 cu. ft. per bbl. per 1000 ft. and is somewhat lower than the quantity generally estimated as necessary for operation—approximately 500 cu. ft. per bbl. per 1000 feet. Other wells in California are being produced with as little as 300 cu. ft. per bbl. per 1000 ft. daily, and of the present installations now numbering nearly 30 in the state, many demand less than the estimated amount of 500 cu. ft. per bbl. per 1000 feet.

Deep wells on plunger-lift in the Kettleman Hills field usually are produced through a choke. In one 8400-ft. well producing through 4-in. tubing the flow is beaned to ¾ inch, and the production is 230 bbl. of oil and a little water from a depth of 8200 ft., the tubing being set nearly 200 ft. off bottom. The well last produced by gas-lift 84 bbl. daily and then quit. Since then it has been producing by plunger-lift with a gas input of nearly 900,000 cu. ft. daily and a gas output of a little more than 1,000,000 cu. ft. daily. The casing pressure is 265 lb. and the maximum tubing pressure 160 lb. per sq. inch. On the downstream side of the flow bean the pressure is 70 lb. per sq. inch.

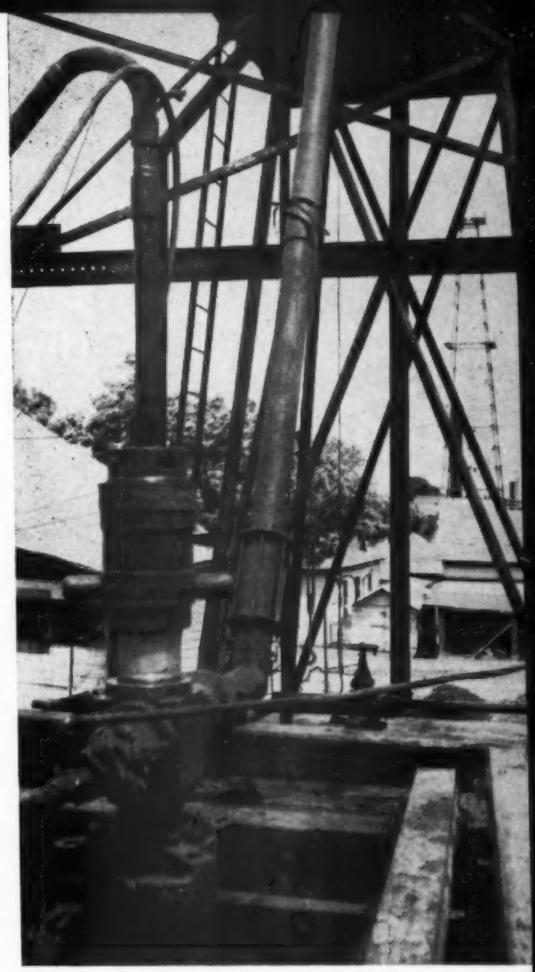
Small gas requirement for lifting is indicated for large production from great depth. Another deep well of large production at Kettleman Hills is producing on plunger-lift 402 bbl. of oil and six bbl. of water through a 1-3/32-in. choke from a depth of 7800 ft. in an 8100-ft. hole. The gas input is slightly more than 800,000 cu. ft. daily and the output is approximately 360 cu. ft. per bbl. per 1,000 feet. The casing pressure on this well is 260 lb. the maximum tubing pressure 172 lb., and the back-pressure maintained by the choke 56 lb. per sq. inch.

Frequently it is necessary to kick-off a well when the plunger-lift is installed and in wells where pressures sufficiently high are not available, the flow can be started by swabbing. The recommended practice during swabbing is to have a line pressure on the casing to assist the swabbing operation. Portable compressor units probably can be used to advantage for kicking-off a well but no specific instances of use of this method have been reported in California.

Several other practices, depending on conditions, are recommended by the manufacturer for small wells with high formation pressures where it is necessary to set deep in the hole to get the required production. These include pumping oil into the well to get circulation and at the same time supplying gas to the casinghead. Where gas pressures of 500 to 600 lb. per sq. in. are available, the head of fluid often can be kicked-off by putting gas through the tubing and gas-lifting the fluid through the annular space between the tubing and casing until the amount is reduced sufficiently so the flow can be reversed and the remaining head of fluid gas-lifted through the tubing.



Timing the stroke in a plunger-lift installation. The sound made by the opening of the valve at the top of the stroke and by the striking of the plunger at the bottom of the stroke is heard readily when the ear is placed against the connection



Well in Oklahoma City field produced by gas-lift/Reda pump combination method

Recent Developments in Gas-Lift Methods

By S. F. SHAW

Profitable gas-lift operations depend largely on supplying gas to wells at low cost

CONTINUOUS gas-lift still is the most important phase of this method of producing oil, and is followed closely by combination gas-lift methods, of which several types have been introduced. Intermittent gas-lift is not being employed to so great an extent as was the case two or three years ago.

The proper layout of compressor plants in connection with gas-lift operations is receiving more detailed attention, owing to the fact that the economies of gas-lift methods are intimately interwoven with proper layout and operation of the plant.

Probably greater attention also is now being paid to a better arrangement at the wells where gas-lift methods are to be employed, and in order to achieve the best results this attention should begin immediately the selection of the sizes of casings comes up for consideration.

Continuous or "Straight" Gas-Lift

Continuous gas-lift operations are those in which the compressed air or gas is introduced continuously into the tubing or casing, and the flow of oil and gas from the well continues as a steady flow throughout the day. This method also is called "straight" gas-lift. It has been employed during the past year in various states, particularly in California, Louisiana, Oklahoma, and Texas.

During the year, wells were completed on gas-lift in various California fields, including El Segundo, Inglewood, Kettleman Hills, Long Beach, Midway-Sunset, Playa del Rey, Santa Fe Springs, Seal Beach, Ventura Avenue, and West Coyote. Fluid levels in most of these fields stand high in newly-opened areas, and when there is insufficient gas to flow the wells naturally, these wells, as a rule, can be produced on gas-lift without the expenditure of a large capital oulay.

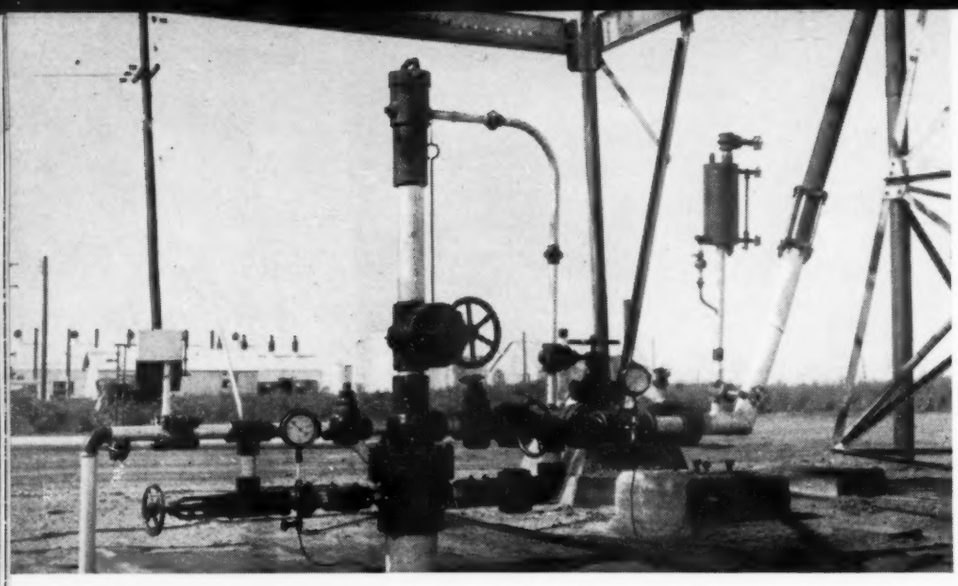
Oklahoma remains the principal state producing oil by gas-lift, largely because of the extensive use of this method in the Oklahoma City field. There are indications, however, that Texas gradually will supplant Oklahoma as the state in which gas-lift will be employed to the greatest extent.

In the early days of gas-lift operations in the Wilcox zone of the Oklahoma City field, the prediction was made that continuous gas-lift would become inoperative when the reservoir pressure had declined to 300 pounds. This was at a time when the gas-lift wells were mostly those in which 6⅝-in. and 7-in. casings had been employed, and it is not surprising that after the pressures began to decline severely the engineers making these forecasts became alarmed at the results being obtained in casings of small sizes, both on the score of lack of capacity and the high consumption of input gas for lifting the oil. The use of larger sizes of casing in certain wells in the Oklahoma City field—a practice begun in the Seminole field—had, however, pointed to the fact that large production could be obtained even with low bottom-hole pressures, and without prohibitive consumption of input gas. When the Capitol area was opened, nearly all wells were completed with sizes of casing ranging from 8⅝-in. to 9⅝-in, so it was found that continuous gas-lift could be extended to wells whose bottom-hole pressure was far below 300 pounds. Examples of production that were made in four wells in this field with low pressures are given in Table 1.

The deposition of paraffin on the walls of the casing as pressures decline in continuous gas-lift operations continues to be a serious hindrance in some fields, and it is only by an exacting system of solvent application that this difficulty can be alleviated. The correct quantity of the right kind of solvent should be employed, and the intervals between treatments must be very carefully worked out.

In the East Texas field many wells are being produced by gas-lift that have "gone dead," or that will not flow naturally unless "kicked off." Perhaps the majority of these wells are connected to gasoline plants from which the residue gas at approximately 300-lb. pressure is distributed throughout the area to those wells from which

A well on "straight" gas-lift in the Corpus Christi field, Texas



A well in Keokuk Falls pool, Oklahoma, producing on plunger-lift with 4-in. tubing

the gas is obtained, in this way making for an economical set-up both from the standpoint of capital outlay and from the viewpoint of operating costs.

Numerous wells in the East Texas field have been equipped with "flow" valves, or "kick-off" valves, and many so equipped are hooked up with the residue lines from gasoline plants to facilitate starting the flow of the wells. In the early days of the field, most of these wells would flow naturally after being started, but the number is growing in which the application of gas is required throughout the entire period during which the well is producing its allowable. A description of the various forms of starting valves was prepared for the A.P.I. meeting in Kilgore in May, 1937, by the engineer of one of the major companies employing these valves to a considerable extent.

TABLE I

Quantity of Oil Lifted Under Low Pressures in the Oklahoma City Field

Well	Lb. Pressure	Bbl. Daily	Input Gas (cu. ft.)		Output Gas (cu. ft.)	
			Total Daily	Per bbl.	Total Daily	Per bbl.
A	61	705	3,715,000	5,255	4,086,000	5,795
B	61	683	2,735,000	4,004	3,987,000	5,837
C	53	547	3,140,000	5,740	3,810,000	6,960
D	41	525	2,390,000	4,560	2,920,000	5,560

The use of gas-lift in the form of continuous flow, or in connection with flow-valves, is spreading in the South Texas area, as well as in West Texas fields. In the South Texas area, "jetting" is the term applied to gas-lift. In the Refugio field, continuous gas-lift has been employed for several years for lifting large quantities of fluid, of which only about ten percent is oil, the gas being supplied from a nearby gasoline plant.

In the Corpus Christi area, where water has encroached rapidly, continuous gas-lift is employed for lifting quantities of fluid ranging from 1000 to 3000 bbl. daily, the oil content of which varies from 4 percent to 50 percent. Flow valves were introduced early in the life of this field for starting wells that periodically "went dead" when the wells were closed-in after having made their allowable for the day. Gas for this purpose is obtained from gas wells usually in the immediate vicinity. Gas obtained locally is rapidly declining in pressure and volume, and it is becoming necessary to install compressor plants in the Corpus Christi area for continuing this work.

Intermittent Flowing Operations

The intermittent flowing of wells is not so prominent a feature of gas-lift operations as was the case a year or two ago, although the plunger-lift type of intermittent flow seems to be spreading gradually over a wide area.

A few instances of intermittent flow are observed in the Oklahoma City field; however, in this field, the adoption of larger sizes of casing has delayed the time when intermittent flow usually has been considered necessary; moreover, the use of intermittent flow of the type in which a packer is employed and in which the flow takes place through the casing, does not operate so successfully in a large casing as in a small casing, owing to the fact that large quantities of gas are required for lifting the oil. Another factor that has discouraged the use of intermittent flow, is the use of combination gas-lift methods in which much larger quantities of liquid can be lifted than with intermittent flow.

The plunger-lift method has made some headway in California during the past two years, there being some 20 installations in Coyote, Dominguez, Huntington Beach, Kettleman Hills, Mountain View, Playa del Rey, Santa Fe Springs, Seal Beach, Shiells Canyon, and Ventura Avenue.

There are two installations of plunger-lift at Coyote at depths of approximately 4000 ft., lifting 190 to 225 bbl. daily; one at Dominguez at 5000 ft. in depth, lifting 150 bbl. of fluid daily; one at Huntington Beach at 3850 ft., lifting approximately 60 bbl. daily; two at Kettleman Hills at 7000 to 8200 ft., lifting 65 to 660 bbl. daily; three at Mountain View at 5500 to 6000 ft., lifting 90 to 250 bbl. daily; one at Playa del Rey at 6300 ft., lifting 150 to 300 bbl. daily; two at Santa Fe Springs at 6700 to 6800 ft., lifting 100 to 140 bbl. daily; one at Seal Beach at 5600 ft., lifting 95 bbl. daily; four at Shiells Canyon at 3100 to 3900 ft., lifting 80 to 300 bbl. daily; and three at Ventura Avenue at 6800 to 7400 ft., lifting 90 to 100 bbl. daily.

In Oklahoma there are 23 plunger-lift installations at Crescent, Edmond, Keokuk Falls, Lucien, and Oklahoma City. At Keokuk Falls, there are three 4-in. tubing installations that are obtaining quite favorable results under very low bottom-hole flowing pressures. The casinghead pressure on the wells when producing is approximately 40 to 60 pounds. Occasionally, when the wells "go dead," it requires 1200 to 1400-lb. pressure to kick the wells off.

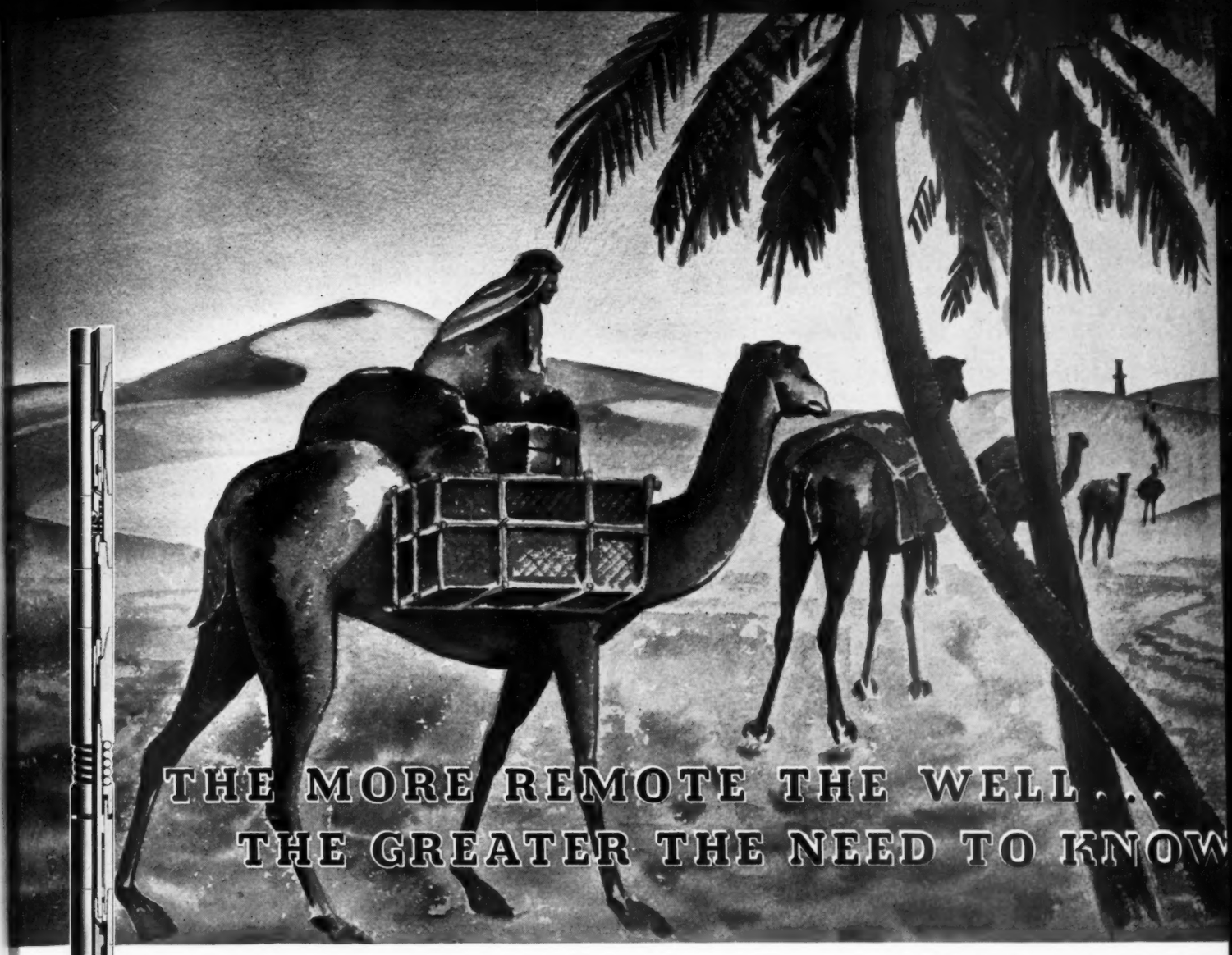
In Texas there are some 20 installations of plunger lifts, approximately 16 of which are in the Pettus field. There are two installations at Cayuga operating at a depth of about 4000 ft., lifting 90 to 150 bbl. daily; and two installations in the Conroe field at 4750 to 5150 ft., lifting 20 to 50 bbl. daily. The Pettus installations were made for the most part in 1932, and have been operating to the present time, and production now is from 20 to 85 bbl. daily at a depth of approximately 3900 feet.

Combination Gas-Lift Methods

Considerable progress has been made in gas-lift operations in combination with other methods. There have been three combination methods tried during the past ten years:

1. Sucker-rod pump in combination with gas-lift.
2. Submerged centrifugal electric pump in combination with gas-lift.
3. Kobe hydraulic pump in combination with gas-lift.

The sucker-rod pump combination



Drawing from photograph of Eastern Saudi Arabia

OIL in Arabia! Kuwait, Hasa, Trucial Coast—these names mean something to the men exploring this vast new territory . . . mean thousands of miles of trackless, waterless, scorching sands stretching from Persian Gulf to Red Sea . . . mean perplexing transportation problems, limited supplies, and a fabulous price on even the simplest kind of development program.

It is highly significant that the Johnston Formation Tester was an indispensable part of the first oil supplies into these uncharted wastes, for operators knew there could be no "second guessing." Every move must count, and the exact production possibilities of each formation must be accurately known BEFORE SETTING CASING.

Arabia is just one of the many oil countries throughout the world where progressive operators rely on the Johnston Tester to guide their development program accurately. By bailing the hole dry through the drill pipe, it tests the well under *actual producing conditions* without the need of setting casing, and traps and brings to the surface an actual sample of the formation fluid for close inspection and laboratory test. The inside information it gives enables the operator to forge ahead smoothly and accurately, confident that every step is a *right* step toward the best development of his field.

Write for complete information on the outstanding features of the Johnston Formation Tester—features that insure the ultimate in accuracy, safety, dependability. A 22-page illustrated booklet will be gladly sent on request!

"WHY SET CASING BEFORE YOU KNOW?"...

was tried out in Seminole several years ago, but failed to perform satisfactorily.

The submerged electric centrifugal pump in combination with gas-lift has met with surprising success in the Oklahoma City field where it was found that very large quantities could be lifted from a depth of 6500 ft. under low bottom-hole pressures. As much as 4500 bbl. daily was lifted when the bottom-hole reservoir pressure was as low as 60 lb. per sq. inch. This method operates to best advantage in wells in which the sand is very little loose, and gas is produced with the oil.

The latest development in combination methods is the use of the Kobe hydraulic pump in combination with gas-lift. A packer is set a few hundred feet above the pump, and the fluid passing through the pump is lifted above the packer, at which point compressed gas is introduced, raising the fluid to the surface. A string of 3-in. tubing is suspended in the well, within which there is a string of 1¼-in. tubing. The "power" oil that drives the Kobe pump passes through the 1¼-in. tubing to and through the pump, thus actuating it, and joins the oil lifted from the bottom of the well between the casing and tubing. The gas, introduced from the surface, passes through the annular space between the 1¼-in. tubing and the 3-in. tubing, and issues into the casing just above the packer.

In the Oklahoma City field, the production of the Barnsdall well No. 6 Bracht on combination Kobe pump totals from 800 to 2000 bbl. daily. The production for July on this unit was 24,000 bbl. and during August was 26,000 bbl., the full capacity not being employed because of proration restrictions. The gas introduced into the annular space in well No. 6 Bracht amounts to 2000 to 3000 cu. ft. per bbl. of oil from the reservoir.

This pump has an advantage that as soon as the production of the well has declined to where it is unnecessary to employ gas-lift, it can be changed readily to a straight Kobe pump, in which a maximum of about 400 bbl. daily can be lifted through the 3-in. tubing at a depth of 6500 feet.

During the past year, fewer "gadgets" were in use in connection with gas-lift operations. A good many such devices were tried out and employed during the time when intermittent flow methods were in demand. The greatest progress during the last year or two has been in the use of "starting" valves or "flow" valves. Booster collars also are used that consist merely of holes drilled in collars of the tubing, through which gas can pass into the flow string, thus allowing the well to be started at a lower pressure than otherwise would be the case. All starting collars, to be most effective, should be spaced at the proper intervals, and should have the proper size opening through which the gas must pass; but insufficient attention has been paid to these details to accomplish the best results.

Operators are, perhaps, coming to realize that profitable gas-lift operations depend largely on supplying gas to the wells at a cost as low as possible. When gas from a gas well is employed, the matter of cost is not particularly noticeable, but when large sums must be spent for the installation and operation of compressor plants, this item of cost comes to the fore in a most pronounced manner.

The installation cost of a plant, based on the barrel lifted, will depend on the barrels actually produced throughout the life of the plant. If only a small quantity of oil is lifted throughout the life of the plant, the owner owes it to himself to be wary of the capital necessary to invest in a gas-lift plant. The cost item of depreciation for compressing gas depends on the length of time that the plant will operate, and on the percentage of the time that the plant is in operation.

Operating costs in the past years for gas-lift plants have been altogether too high. These costs have ranged from half a cent per M. cu. ft. to ten cents per M. cu. ft., the more usual cost being five cents to ten cents per M. cu. feet. In a plant having a daily capacity of 7,000,000 cu. ft., or rated at about 1000 hp., the operating costs should be about one cent per M. cu. ft., and in a plant producing 25,000,000 to 30,000,000 cu. ft. daily, the operating costs should be approximately ½ cent per M. cu. feet. If these costs are actually obtained in practice, it readily can be seen that the lifting cost per bbl. is a small item even though comparatively large quantities of gas must be employed per bbl., and such becomes the case when the flowing pressures decline to a low point.

Recent tests in a field in which the wells produce from a depth of 4100 ft., and large quantities of water accompany the oil, indicate that the quantity of gas required is approximately 600 cu. ft. per bbl. of liquid. The oil content is about ten percent of the liquid, thus making the quantity of gas required per bbl. of oil approximately 6000 cu. feet. If gas can be produced at one cent per M. cu. ft., it can be seen that the lifting cost at six cents per bbl. is a low figure, especially for such conditions. Depreciation must be added to the operating cost, but if the depreciation charges involve a cost that is equal to, or even double, that of the operating cost, the expense for lifting the oil is not at all prohibitive.

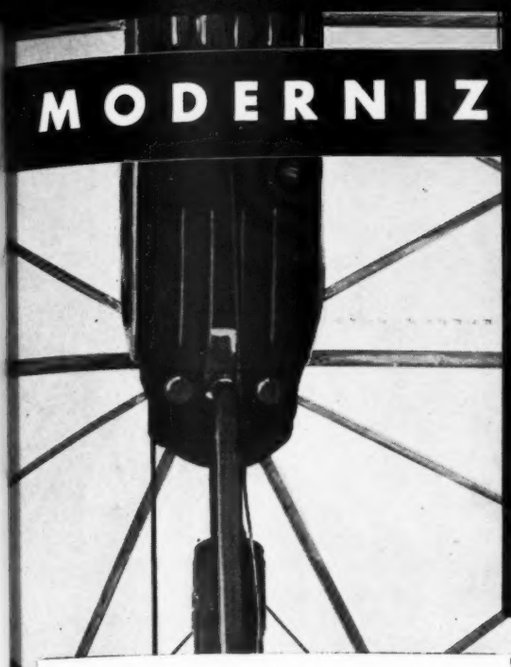
Outlook for Gas-Lift Operations

New developments in gas-lift operations for the coming year are not easy to forecast. Production restrictions have much to do with the use of the gas-lift. When there is insufficient demand for the oil in a given field to warrant speeding up to the capacity of the wells, the operator is satisfied with getting his allowable in as convenient a manner as possible, with the minimum outlay of capital for equipment, and at minimum lifting cost. When production is severely restricted, it is only natural that wells will continue to flow naturally for a longer time, and as long as the allowed production can be obtained by natural flow it is to be expected that the operator will continue to lift his oil in this manner.

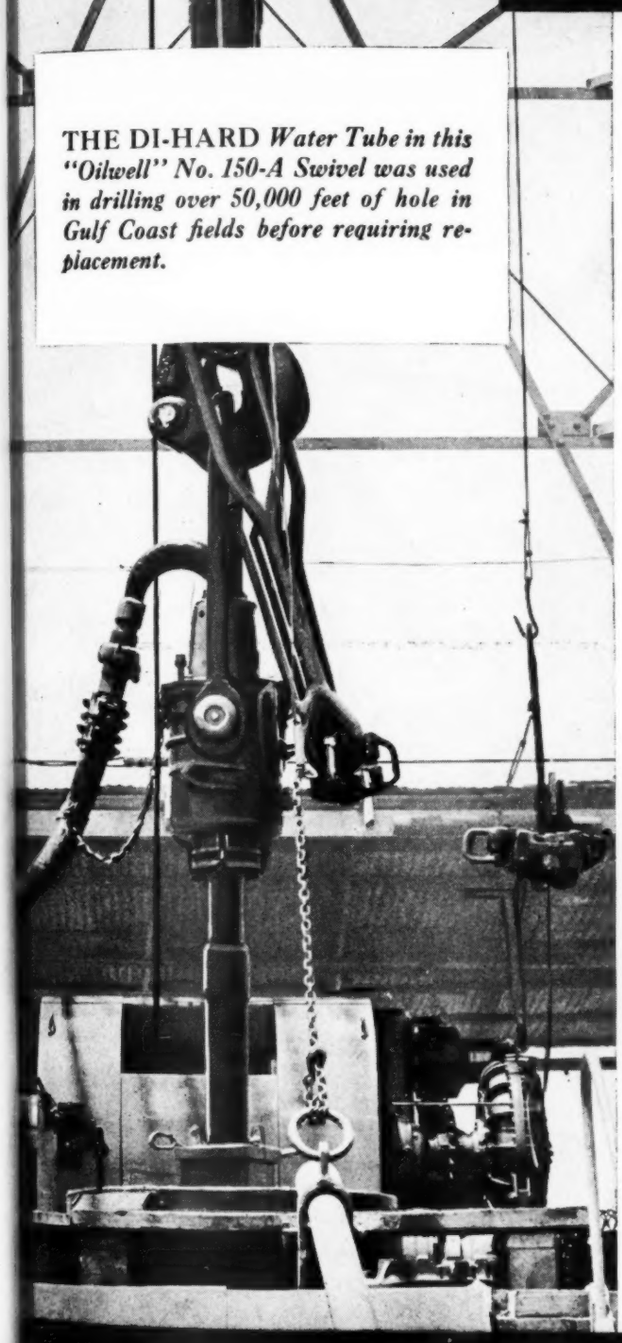
On the other hand, when natural flow ceases, or when natural flow does not permit the operator to produce as much oil as he is allowed, he turns to

Barnsdall Oil Company Well No. 6 Bracht, Oklahoma City field, on gas-lift/Kobe combination method

MODERNIZE YOUR ROTARY RIGS



THE DI-HARD *Water Tube in this "Oilwell" No. 150-A Swivel was used in drilling over 50,000 feet of hole in Gulf Coast fields before requiring replacement.*



"OILWELL" Swivels give trouble-free service. There are many reasons. Here are three:

DI-HARD Water Tube—

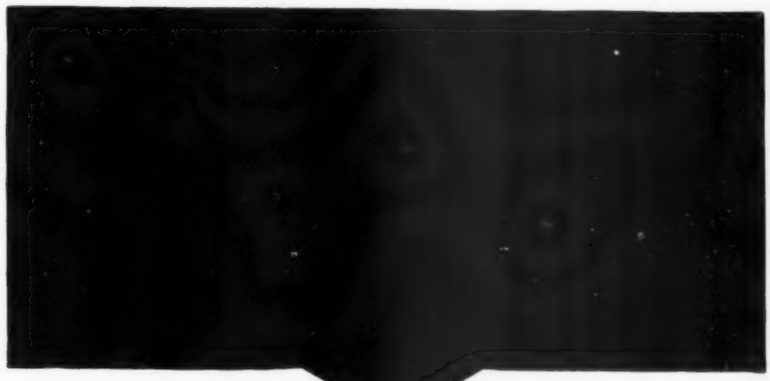
- ★ is extremely hard—over 600 Brinell
- ★ is highly resistant to abrasion
- ★ has a very low coefficient of friction
- ★ outwears many times the best heat-treated steel tubes . . . packing lasts much longer

Type "A" Water-Tube Packing—

- ★ requires no adjustment
- ★ prevents leakage under all pressure and temperature conditions
- ★ outlasts other packings and prolongs water-tube life

Extra-heavy, heat-treated Goose Neck with reinforced Long-Radius Bend—

- ★ reduces flow restriction
- ★ gives much longer service than conventional type



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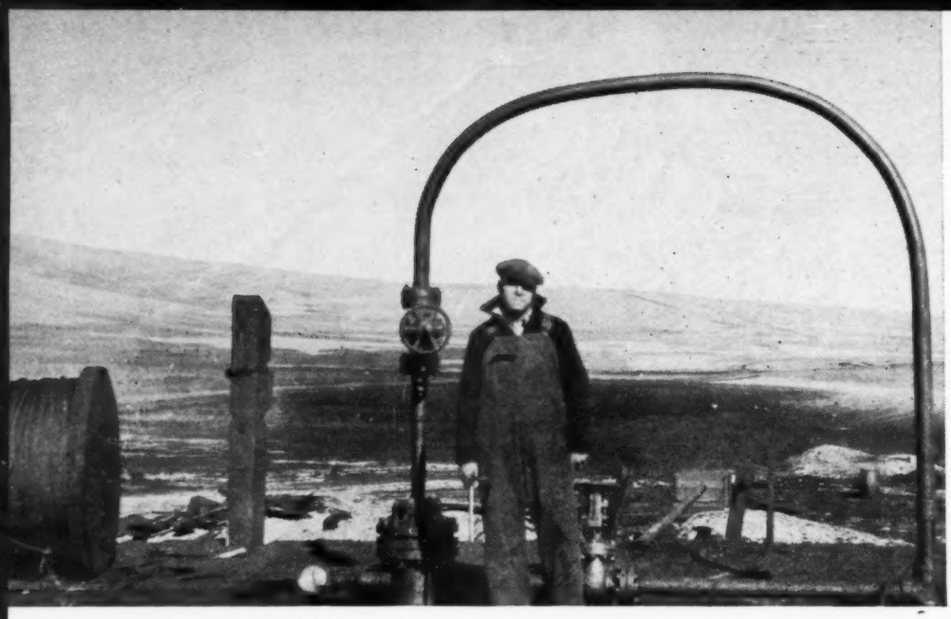

Well in Turner Valley field, near Calgary, Canada, equipped to flow by gas-lift and natural flow

gas-lift for large-capacity low-cost operation, as the first remedy. If the wells are small in capacity, he is likely to employ the beam pump or central power, if the depth is not too great, or if the holes are not too crooked.

Continuous gas-lift operations are more dependable than the modified forms of gas-lift. They cover a wider range of conditions, and can be laid out with much lower capital outlay and operated at a cost that usually is lower than other forms of gas-lift; moreover, continuous gas-lift employs to advantage all the gas that is produced with the oil. There may be special conditions that preclude employing straight gas-lift. It may not be possible to lift the quantity of oil that can be obtained by using combination methods; and in some cases continuous gas-lift does not produce the volume obtained by intermittent flow. Casing diameters may be such that modified forms of gas-lift may be necessary both for the sake of producing greater volumes and for obtaining a lower consumption of gas than is the case with continuous flow by gas-lift.

It seems likely that the Kobe hydraulic pump in combination with gas-lift may be extended in the future to handle production in large volume in wells of low bottom-hole pressure.

Areas in which the differential pressure between the reservoir and the well is high (that is, areas in which the sand is tight, and, therefore, production is not large for a given reservoir pressure) the plunger-lift has an important field of application.

It would seem likely that there will be a gradual expansion of gas-lift activities in the East Texas field, owing to the peculiar conditions that make capital outlay and operating costs on gas-lift very low in that field. In the deeper fields, such as Conroe, Anahuac, Kettleman Hills, and the deeper zones of some of the California oil fields, also in the Louisiana and Texas Gulf Coast fields, gas-lift probably will come in for serious attention as soon as natural flow ceases. In areas such as Corpus Christi, where the flowing pressure is fairly high, and where large volumes of water must be lifted at low cost, it is probable that gas-lift will be of considerable benefit.

The Turner Valley field in Alberta, Canada, where the wells are completed at depths of approximately 6500 ft., recently has witnessed a large increase in production brought about by acidization of several of the wells. Differential pressures between the reservoir and the well have been reduced by acidizing the wells and may make it desirable to use gas-lift in some form after the reservoir pressure has declined somewhat. Continuous gas-lift may be desirable in some wells; in others the Reda or Kobe combination method might be employed; and in wells of tighter formation, the plunger-lift might be of advantage.

Dedication of Petroleum Station at Bartlesville, Oklahoma

THE new building of the Petroleum Experiment Station of the United States Bureau of Mines at Bartlesville, Oklahoma, will be dedicated on October 19th and 20th. The Bartlesville Chamber of Commerce is coöperating in an extensive program to mark the dedication as a memorable occasion. The governors and the congressional delegation of Oklahoma and oil-producing states in the Mid-Continent area have been invited to attend the ceremonies, as well as other prominent government officials and well-known figures in the petroleum and natural-gas industries.

The Bureau of Mines, as it relates to the oil and gas industry, is a research organization whose function is to provide answers to the many technical and economic questions that are arising continually in the industry. Its staff of specialists has access to data that are not available generally to the competitive units within the industry, and consequently the Bureau is especially prepared to analyze technical problems in which economic considerations are important factors.

The Petroleum Experiment Station at Bartlesville was founded in 1917, and since that time several hundred reports dealing with all branches of the petroleum and natural-gas industries have been published by the Bureau of Mines. These reports include studies of the problems involved in drilling and production, transportation, refining and chemistry, and the use of oil and gas and their products. Particular emphasis is laid on reduction of waste, on safety and efficiency, and on economic development.

The new building, which was completed early this year, contains the administrative offices, library, and chemical laboratories of the station. The central part of the building is 100 ft. long and 50 ft. wide, three stories high with a basement. This part of the building is flanked by two wings, each 57 ft. long and 37 ft. wide, consisting of two stories and basement. The first floor contains the offices and the station library. The upper floors are used for laboratories.

The laboratories are well designed and equipped for distillation of petroleum and for physical and chemical determinations on oils, gases, and oil-field waters. Construction and equipment have been provided in accordance with best modern practice so that accurate work may be done with maximum efficiency. In design and equipment the laboratories compare favorably with the research laboratories of colleges and universities and progressive oil companies.

The library has 5000 volumes devoted to petroleum, natural gas, helium, oil shale, and allied substances, and dealing with their geology, development and production, chemistry and refining, and economics.

World's deepest OIL WELL cemented with UNAFLO

Two new world records were established in the oil fields this year . . .

The deepest well ever completed as a producer was brought in.

The deepest oil well cementing ever attempted was successfully accomplished.

Unaflo was the cement. It was chosen on its record of success in casing and plug-back jobs and also on the basis of the well company's laboratory tests.

The temperature was 218° F. eight hundred feet above the casing shoe. This is hot—but Unaflo is tested to 360° F.

Time for the complete operation was 1 hour and 22 minutes. Unaflo is pumpable 2 additional hours at this temperature. But it was a good test of the pumpability of Unaflo. 430 bags mixed 15 pounds per gallon were landed with a single slush pump at 1250 pounds per square inch maximum pump pressure.

On this same well, Unaflo was used to plug back. The operation was completed without mishap at this high temperature.

No ice was used in cementing this well.

Cement drilled up was "hard."

Try Unaflo on *your* next job!

Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Amicable Bldg., Waco, Texas; Kansas City; Tulsa; Oklahoma City.

UNAFLO CEMENT—

1. Retains fluidity at highest known oil well temperatures.
2. Permits use of ½ gallon less water per sack of cement.
3. Has set a new record for low pump-down pressures.
4. Follows irregularities of well bore and casing.
5. Attains full strength rapidly under high temperatures.
6. Remains fluid even when contaminated by mud.
7. Remains fluid while being placed, thus forming an impermeable seal against the movement of formation fluids.
8. Has proved in the field that it "sets up" in sulphate waters.
9. Has repeatedly remained fluid for more than two hours on squeeze jobs where pressures and temperatures were extreme.
10. Is a safer cement for oil string and repair jobs.

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FOR SAFE DEEP-WELL CEMENTING

Data on Behavior of Water and Oil Passing Through Unconsolidated Sand

By ALEXANDER B. MORRIS[1]

Experimental Results Suggest Possible New Line of Investigation — Sand Characteristics Susceptible of Accurate Measurement

DURING the course of experiments recently made by the writer, some very interesting data were collected on the behavior of water and oil in their passage through loose, unconsolidated sand. As porosity, permeability, and drainage problems now claim so much of the time and attention of the petroleum engineer, it was thought that these data would be of interest and of possible assistance to someone faced with a practical operating problem, even though they are in themselves largely inconclusive. The great scarcity of such data in readily accessible publications should render any little contribution to the store the more welcome.

The apparatus used in these experiments was an 8¼-in. by 2-in. swaged nipple, closed at the small end by a 2-in. by 1-in. reducer, a 1-in. by ¾-in. bushing and a perforated cork, penetrated by a piece of ordinary laboratory glass tubing of approximately ⅛-in. I. D. The nipple was supported, small end down, by a tripod. Gallon jugs equipped with 2-hole stoppers and syphon tubing were used to charge the apparatus from below, using compressed air. The materials used were fine white sand such as is used for inside finish plaster, fresh Bartlesville-sand crude oil from the Tulsa Airport field, and tap water. The oil was kept in a 5-gal. can. At the beginning of the tests the gravity was 41 deg. A. P. I. After about ten days of standing in this frequently-opened can, at room temperatures between 90 and 100 deg., the gravity had diminished to 39 deg., but the oil was still "live" enough to froth upon pouring. No physical constants were taken, and the sand was used without additional desiccating. As this sand comes from the supply house packed in heavy paper sacks, and is never exposed to the weather, the initial water content probably does not exceed two per cent. Most of the sand would pass a 40-mesh screen.

In order to prevent this fine sand from flowing out of the nipple, a "well" was prepared as follows:

A small cone, ½ in. by 3 in., was made of 40-mesh screen and placed in the neck of the swaged nipple covering the inside end of the outlet tube. Around this, and completely covering it, was placed fine gravel obtained by sifting ordinary building sand on a 10-mesh screen. Over the top of this gravel, and extending to the beginning of the flare of the nipple, was placed a coarse sand that would pass the 10-mesh screen but be caught by the 40-mesh screen. This filter entirely prevented the loss of any of the fine sand during the course of the runs.

Before preparing this well, the capacity of the nipple was gauged with water. The nipple then was filled level full of the fine sand, which was settled by pounding the sides of the nipple vigorously with a hammer. A number of separate runs were made, and one

(Continued on Page 112)

[1]Petroleum Engineer, Tulsa, Oklahoma.

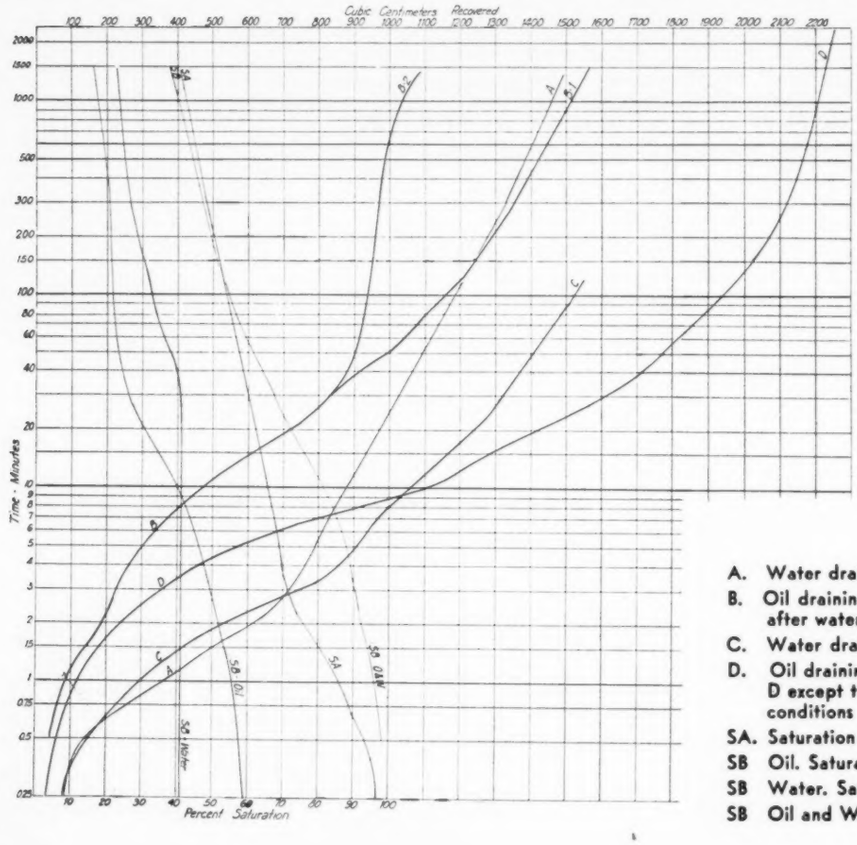

FIG. 1

A. Water draining from clean sand.
B. Oil draining from water-wet sand. Same sand as curve A, after water drainage had almost ceased.
C. Water draining from oil-wet sand.
D. Oil draining from clean sand. No relation between C and D except that they were run in same apparatus and under conditions as nearly identical as possible.
SA. Saturation of water, corresponding to curve A.
SB Oil. Saturation of oil corresponding to curve B.
SB Water. Saturation of water corresponding to curve B.
SB Oil and Water. Total saturation corresponding to curve B.

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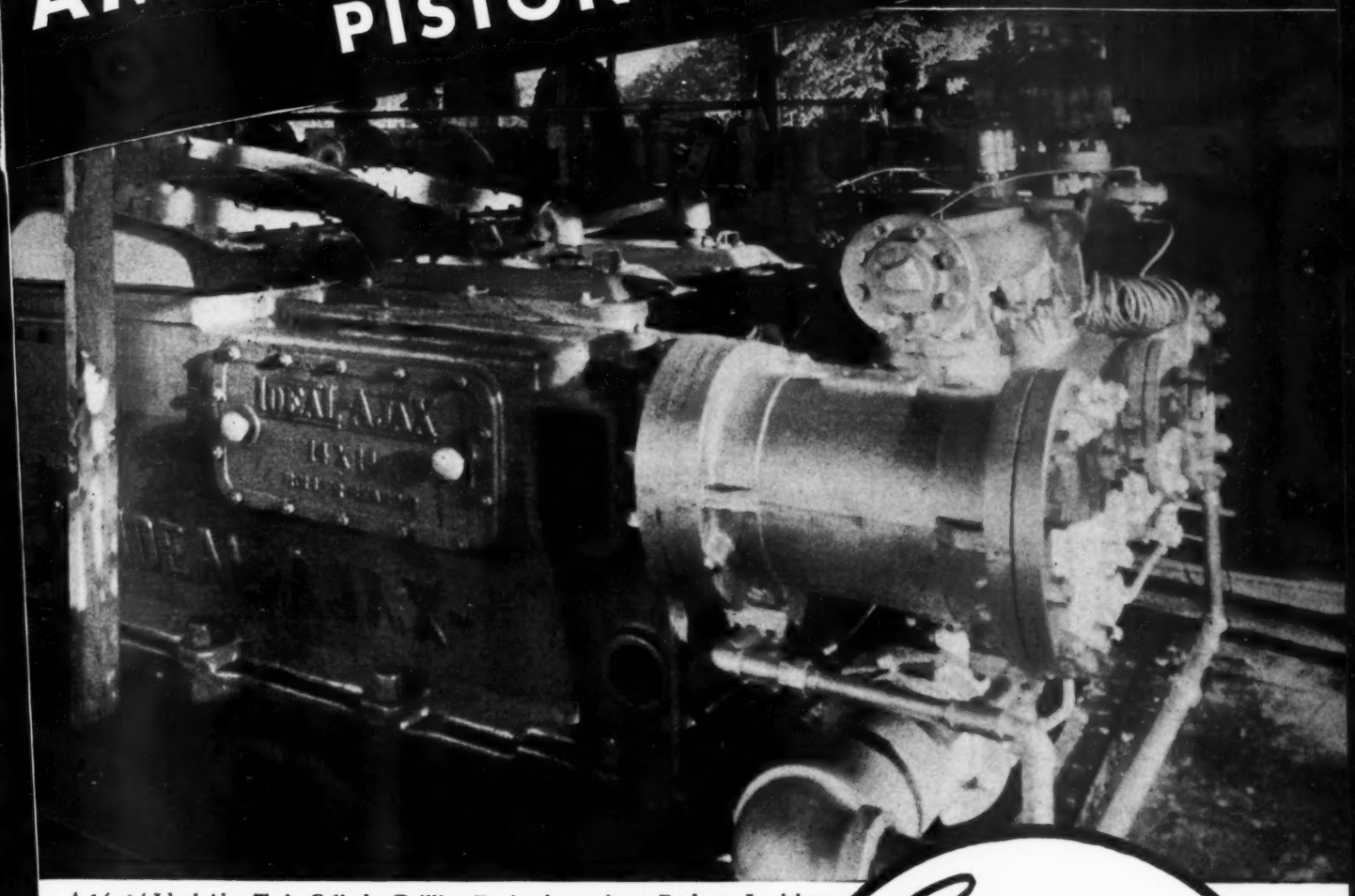

A 14x14 Ideal Ajax Twin Cylinder Drilling Engine in service at Rodessa, Louisiana.

Two miles . . . not such a great distance, as distances go. You can walk it in 25 minutes, ride it in two, fly it in thirty seconds. But two miles *straight down*—that's something else again . . . but just as easy for Ajax.

Ajax drilling engines have drilled some of the deepest holes in the world, including the 12,000 foot Elender No. 1 in Southern Louisiana. They have been noted for advanced design and performance since 1877. With such a reputation to maintain, it is a real tribute that Ajax equips its engines with American Hammered Piston Rings.

In every oil field on earth, you'll find Ajax Engines and American Hammered Piston Rings working together.

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Specialization

STARTS with the METAL

For best service, various piston ring applications demand various properties in the rings. All necessary properties cannot be incorporated in manufacture . . . some must be inherent in the metal. American Hammered Piston Rings are therefore produced in more than 15 different alloys. For example:

For steam . . . an alloy like this

For high speed service . . . an alloy like this

For compressor service . . . an alloy like this

(Continued from Page 108)

of each type is presented in Fig. 1. These were:

Water draining from clean sand.....Curve A
Oil draining from water-wet sand.....Curve B
Water draining from oil-wet sand.....Curve C
Oil draining from clean sand.....Curve D

As it is the present generally accepted opinion that reservoir sands were water-saturated before the access of the oil, only the tests represented by curves A and B are here discussed in detail. It is assumed that the water remaining in the sand before the addition of the oil corresponds to the connate water occurring in actual reservoirs. As all the tests were conducted in open vessels, the results are not complicated to any great extent by gas phenomena, though these may account for some of the peculiar irregularities in some of the curves.

Table I is a record of the data shown graphically in curves A and B in Fig. 1. Curves SA, SB, etc., show the percentage saturation of the sand in the nipple corresponding to the out-flows shown by curves A and B, respectively; however, as curve B records the out-flow of oil from a sand that was 41 percent saturated with water when the oil was charged into it, there are provided three saturation curves corresponding to curve B, one showing the water-saturation, one the oil saturation, and one the total saturation.

The course of procedure, beginning with the charging of water into the nipple prior to recording curve A, was as follows: Water was measured into one of the filling jars, and siphoned upward through the out-let tube, compressed air being applied very slowly, so that 15 minutes was required to fill the sand. It was hoped that by filling slowly, time would be allowed for the escape of all air ahead of the advancing water surface, thus preventing the trapping of bodies of air and assuring complete saturation. In some of the tests this was definitely not accomplished despite all precautions, but it seems to have been substantially accomplished in the test here submitted. The ratio of the quantity of water necessary to saturate the sand completely, to the total capacity of the vessel empty, indicated the porosity of the sand bed. This ratio was 2535/8565, or 29.6 per cent. Owing to the relatively large volume of water contained within the meniscus across an 8¼-in. vessel, exact duplications of "fullness" could not be obtained as between two chargings of the nipple, but it is believed that differences due to this cause will not exceed ten cc.

As soon as the sand was thoroughly saturated, enough water was drained back into the charging bottle so that the surface film appeared to be resting on top of the sand. The water remaining in the charging bottle then was measured to determine the quantity charged into the sand. When the charging bottle had been removed, and a 1000-cc. cylinder substituted for it, the outlet tube was opened. Out-flow readings were taken as follows:

Every 15 seconds to 2 minutes
Every 30 seconds to 6 minutes
Every 1 minute to 15 minutes
Every 5 minutes to 120 minutes.

The apparatus then was permitted to drain over night. In some of the tests it was possible to obtain interim readings at around 300 to 500 minutes; and the test shown in curve D drained for 2500 minutes, several readings being taken during the second day. Most of the tests, however, extended only over a 24-hour period. To revert to the test recorded in curve A, after 1335 minutes, a total of 1490 cc. out of a total charge of 2535 cc. had drained off, representing a recovery of 59 percent and a residual saturation of 41 percent. At that

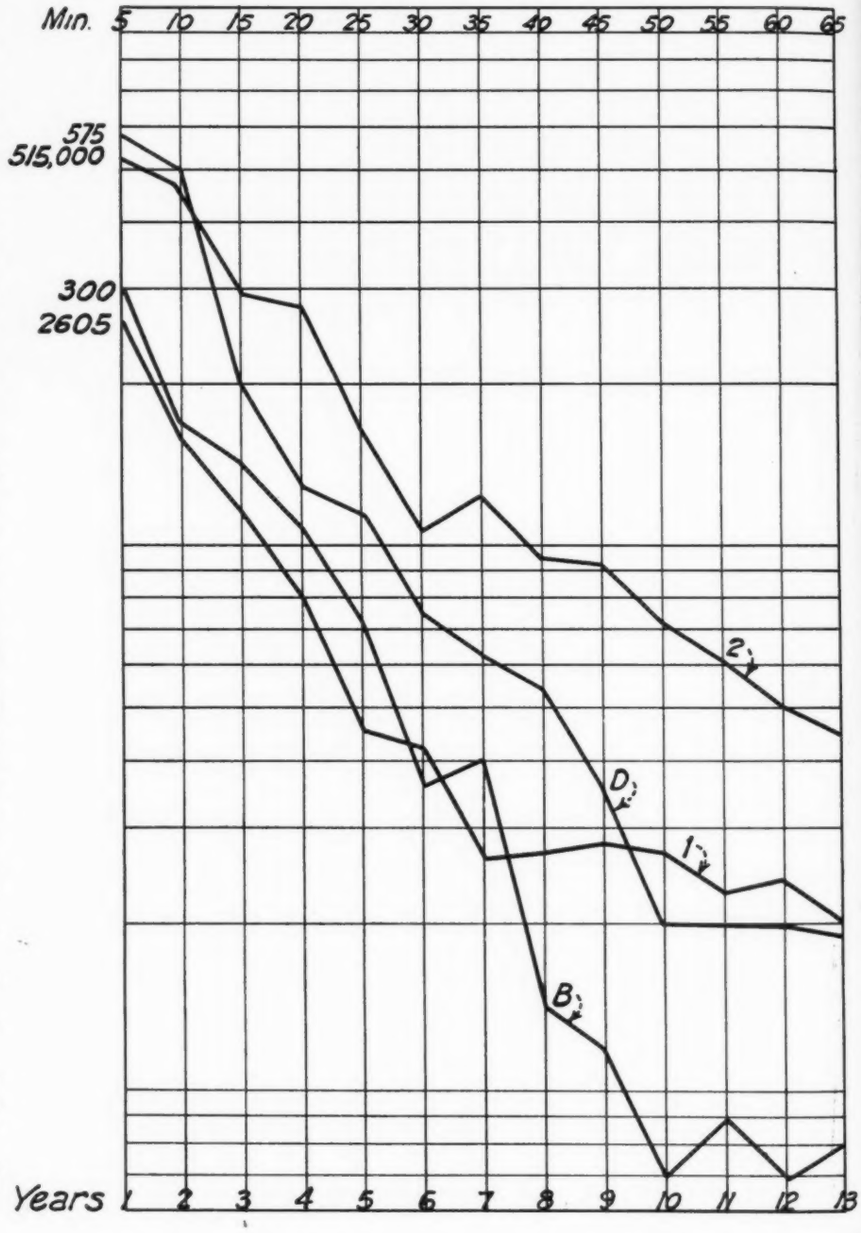

Fig. 2. Comparison of Experimental Results with Actual Decline Curves:

Curve B. Oil from water-wet sand, cc. per 5-min.

Curve D. Oil from clean sand, cc. per 5-min.

Curve 1. Barrels per well per year, Bartlesville sand, Washington County, Oklahoma, 79 wells.

Curve 2. Barrels per well per year, Glenn sand, Glenn Pool, Oklahoma, 21 wells.

Old Cap Carter

puts a steel mill to work

A million American dinners tonight, of delicious deep-sea fish, would never be eaten except for steel. First the old fisherman must mend his nets with a steel needle. Then he puts to sea in a steel boat, unloads his catch into a steel trough, cleans and prepares the fish with steel implements, and finally ships the fish in steel cans plated with tin.

Last year American housewives opened many thousands of tons of these cans .... you could almost say we would be without sea food if it were not for steel.

In the lives of every one of us, steel plays a vital part. That fact is never for a moment forgotten at Youngstown, and research goes on continuously, to keep down the costs and increase the value of the countless steel products you use every day. We feel that we are working for you, the customer, more than for ourselves. That is why you, the user of conduit, can *depend on Youngstown.*

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time drainage had almost ceased, as indicated by the following:

1:30 p.m.-4:35 p.m. 185 min. 120 cc.
4:35 p.m.-9:45 a.m. 1030 min. 165 cc.
As read from curve A 35 cc. had drained off in the final 335 minutes.

The filling bottle then was charged with a measured quantity of oil, which was charged into the nipple in the same manner as that just described for the water. After measuring the quantity remaining in the filling bottle, to determine the quantity charged, the oil was permitted to drain off, readings being taken at the same time intervals. This out-flow is shown in curve B. Notwithstanding the fact that 1045 cc. of water was present in the sand, no water appeared with the oil in the out-flow until approximately the 32nd minute. Branch B-1 records the oil out-flow from this point on; branch B-2 records the total fluid out-flow, oil and water together. The spread between the two branches, therefore, represents the water recovered with the oil during the latter part of the run. At the end of 1515 minutes drainage was still progressing, but at a very low rate, only 4.5 cc. draining off in the final 70 minutes. Of this amount 3 cc. was oil and 1.5 cc. water. The curvature toward the right of branch B-1 represents this increased production of oil with respect to water during the last portion of the period.

In all tests that were run, whether of oil draining from water-wet sand or water draining from oil-wet sand, it was observed that whichever substance heavily preponderated in the reservoir would completely cut off the other from access to the outlet, until such time as the percentage saturation —in terms of the total space originally available for each, respectively—of the two substances were approximately equal. This is shown clearly in the saturation curves here presented. Saturation curve SA records the declining saturation corresponding to the drainage of water from clean sand as per curve A. As water originally was charged into the sand, the entire porosity of the sand represents 100 percent saturation, and the residual saturation at the end of curve SA is 41 percent. This remains constant throughout the first 30 minutes of

DATA FOR CURVES A AND B

	Water	Oil
Measured into charging bottle	3500 cc.	3000 cc.
Left in charging bottle	965	1515
Total charged to sand	2535 cc.	1485 cc.
Total drained from sand	1490	1090
Remaining in sand	1045 cc.	395 cc.

Water Drainage Curve A			Oil and Water Drainage Curve B				
					CC. Recovered		
Time	Elapsed Time	CC. Recovered	Time	Elapsed Time	Oil	Water	Total
11:30 a.m.	0 min.	0.0	10:13 a.m.	0 min.	0.0	0.0	
	¼	85		½	42		
	½	140		1	85		
	¾	260		1½	140		
	1	355		2	190		
	1¼	430		2½	212		
	1½	495		3	230		
	1¾	560		3½	250		
	2	620		4	270		
	2¼	lost		4½	285		
11:34	4	765	10:18	5	300		
	5	790		6	340		
	5½	800		7	370		
	6	810		8	405		
	7	828		9	438		
	8	845		10	470		
	9	859		11	500		
11:40	10	873		12	530		
	11	885		13	560		
	13	907		14	585		
11:45	15	931		15	610		
	17	949	10:33	20	718		
	20	972		25	790		
	25	1000		30	825	0	825
	30	1025		35	865	5	870
	35	1049		40	879	27	906
	40	1066		45	891	56	947
12:15	45	1080		50	899	83	982
1:30	120	1205		55	908	109	1017
4:35 p.m.	305	1325		60	915	133	1048
9:45 a.m.	1335	1490		75	923	163	1086
				80	927	174	1101
				91	934	202	1136
			11:53	100	938	216	1154
				125	944	265	1209
			2:42	269	964	370	1334
			4:48 p.m.	395	978	408	1386
			10:23 a.m.	1445	1088	473	1561
			11:33	1515	1091	474½	1565½

curve SB (water) for the reason that during that 30 minutes of drainage of oil from the water-wet sand (curve B) no water was recovered; however, 59 percent of the total porosity of the sand represents 100 percent saturation with oil. The point on curve B where the branch occurs is at 865 cc. recovery out of a total oil charge of 1485 cc., or 58.5 percent. Thus water first appeared in the stream when the percentage of residual oil approximated the percentage of residual water.

Fig. 2 compares the recovery curves B and D with ordinary "average well" production declining curves. The data for curves B and D were converted to production in cc. per 5-minute interval. The well curves show average per well per year for two Bartlesville sand properties that were developed in 1906-08, and were produced at maximum capacity at all times. It will be observed that all these curves present the same characteristics. Particularly is it to be noted that all reach a point at which the production flattens out, even when plotted on semi-log paper. This point represents the exhaustion of the initial driving force in the case of the wells, the exhaustion of solution gas, and in the case of the laboratory tests the removal of hydraulic head, so that in all cases all the production that was recovered thereafter was only what unaided gravity could succeed in freeing from the sand particles.

This similarity suggests a possible new line of investigation. The porosity, permeability, and other physical constants of a sand mass, such as was used in these tests, are susceptible of accurate measurement. If the initial reservoir pressure in these two Bartlesville sand properties were known, and a core were available from which to obtain the characteristics of the sand, the mean effective characteristics of the entire reservoir could be determined for use in production problems instead of merely postulating conditions throughout the reservoir identical with those revealed by examination of individual cores.

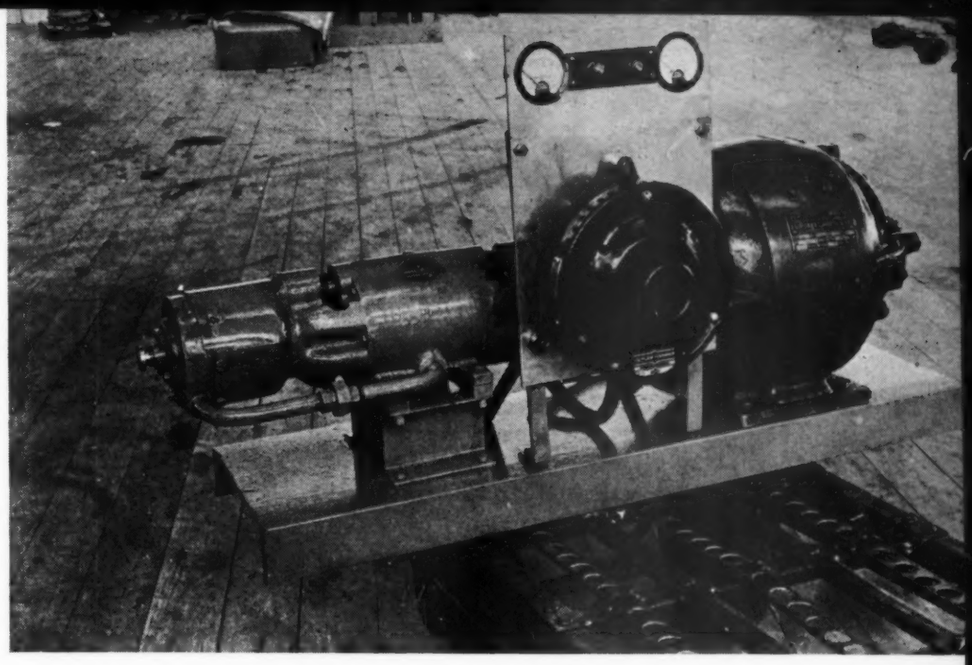

Fig. 1. Machine assembled and just prior to being installed

By
DAVE HARRELL
Corrosion Engineer,
Houston Pipe Line Co.

Rotary Engine Drives Cathodic Protection Generator

Operating on pressure drop around a large regulator at a point of high delivery, fuel cost is eliminated entirely

FOR the past three months the Houston Pipe Line Company has been experimenting with a small cathodic protection unit powered by a rotary engine. It was thought that perhaps a rotary type engine could be made to run on the pressure drop around a large regulator at a point of high delivery and thus obtain several horsepower without consuming any gas and converting some of the work done by the regulator into useful energy.

A local manufacturer had a small rotary engine designed to run on air and steam and agreed to redesign this machine to operate on natural gas at the pressure drop available. Accordingly, such an engine was direct-connected to a 2.4-kw., 1750-r.p.m. generator rated at 60 amp. and 40 volts. The first engine would run, but no horsepower could be obtained, as it was designed to operate on air and the lighter natural gas would "blow by" between the rotor and the cylinder wall; also, only 1-in. pipe was run for a by-pass around the regulator, and although this was large enough to obtain sufficient pressure at the high-pressure intake, such a high back-pressure was set up at the discharge that the engine would not deliver its full rated power. The second engine was machined to two thousandths of an inch clearance between the rotor and the cylinder wall and has been "trued up" to where it will drive the generator at maximum rated load. A 2-in. by-pass was run to replace the old 1-in. one and this relieved the back-pressure and allowed ample gas to flow through the machine to drive the generator up to speed.

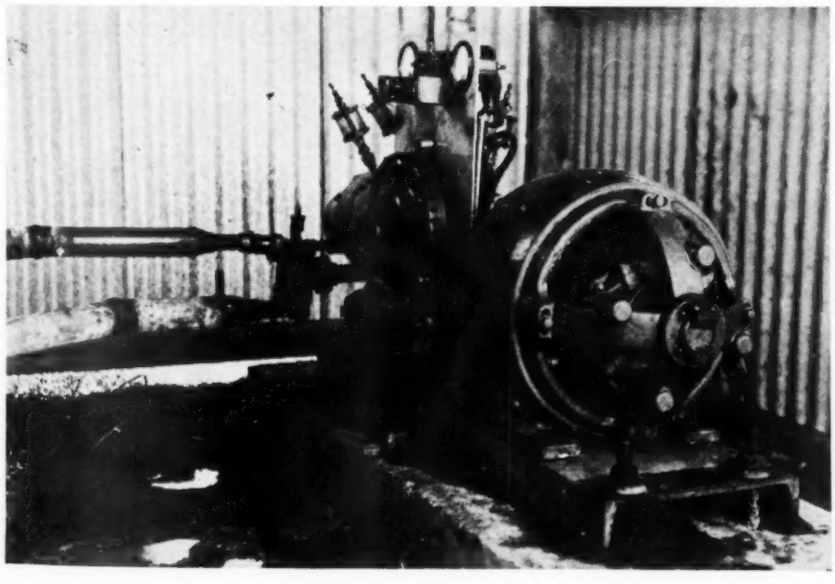

Fig. 2. Engine generator set mounted in house on foundation

Fig. 1 shows the machine assembled as it was just before installing in the galvanized house built for it at the plant of the Freeport Sulphur Company at Hoskins Mound, Texas. The engine and generator were securely bolted to a steel frame made from angle iron and the entire assembly was mounted on a concrete foundation as shown in Figs. 2 and 3. The negative binding post was connected to the 2-in. line and a positive feeder system was constructed from 00 trolley cable mounted on the poles of the pipe line telephone line and running to two joints of 12¾-in. junk pipe buried in a bleed-water ditch. This first anode did not give very good results, as the bleed-water ditch was such a good conductor that it returned about 70 per-

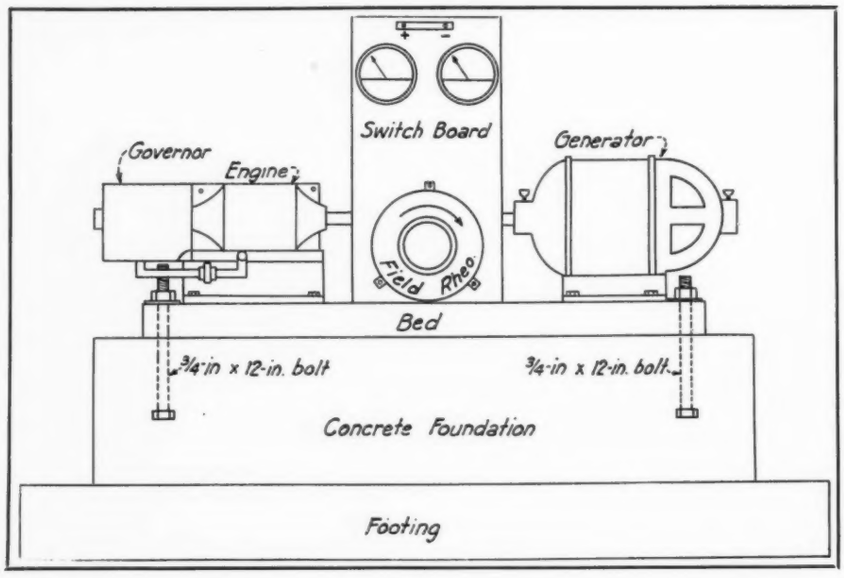

Fig. 3. Diagram of Reed rotary engine

cent of the current to a spot where it crossed the pipe line and did not give sufficient spread of cathodic potential to protect the pipe where it was really in need of protection.

It was found necessary to remove the feeder system from the telephone line as this induced a tone in the telephone wires. A new feeder system was built running directly away from the pipe line on separate poles from those of the telephone line and at the end two joints of 12¾-in. junk were buried vertically to a depth of approximately 17 feet.

The service lines into the sulphur company's plant consist of two 12¾-in. lines that are used one at a time, the dead line serving as a standby. Two regulators and two orifice meters are in service here, one on either line. The details of the by-pass connection are shown in the sketch of one of these service lines (Fig 4).

After the machine was assembled and placed in operation it was desired to determine how much gas was passing through it. This was quite a problem, for it was not thought possible to measure this amount on the large orifice plate in the 12¾-in. service line. It was decided to take gas from the line in service and return it to the low-pressure side through the dead line and note the deduction on the differential around the plate in service. From this it was calculated that the machine passed 510 M. cu. ft. in 24 hours when the inlet pressure was 173 lb. and the back-pressure was 15.5 pounds. Under ency of the generator is 80 percent and that the mechanical efficiency of the

these conditions the machine was putting out 53 amp. at 33.5 volts, yielding a factor of 74.4 cu. ft. per hp. min., assuming that the overall efficiengine is approximately 70 percent. This does not take into account the thermal efficiency of the machine, as this factor is very low and did not concern the passage of gas. Even at low efficiency the heat absorbed by the expanding gas in the machine causes the discharge line to cool to a temperature of about 40 deg., which produces considerable sweating on warm days.

In Fig. 5 the 2-in. by-pass connections to the live service line are shown. The 2-in. gate just to the right of the wheel on the large 12¾-in. gate is in the high-pressure intake while the 2-in. discharge may be seen entering the building through a hole in the galvanized iron just to the left of the pressure gauge. The 12¾-in. regulator is shown just beyond the pressure gauge. Fig. 6 shows the same connections as above to the dead line. The intake may be seen running beneath the 12¾-in.

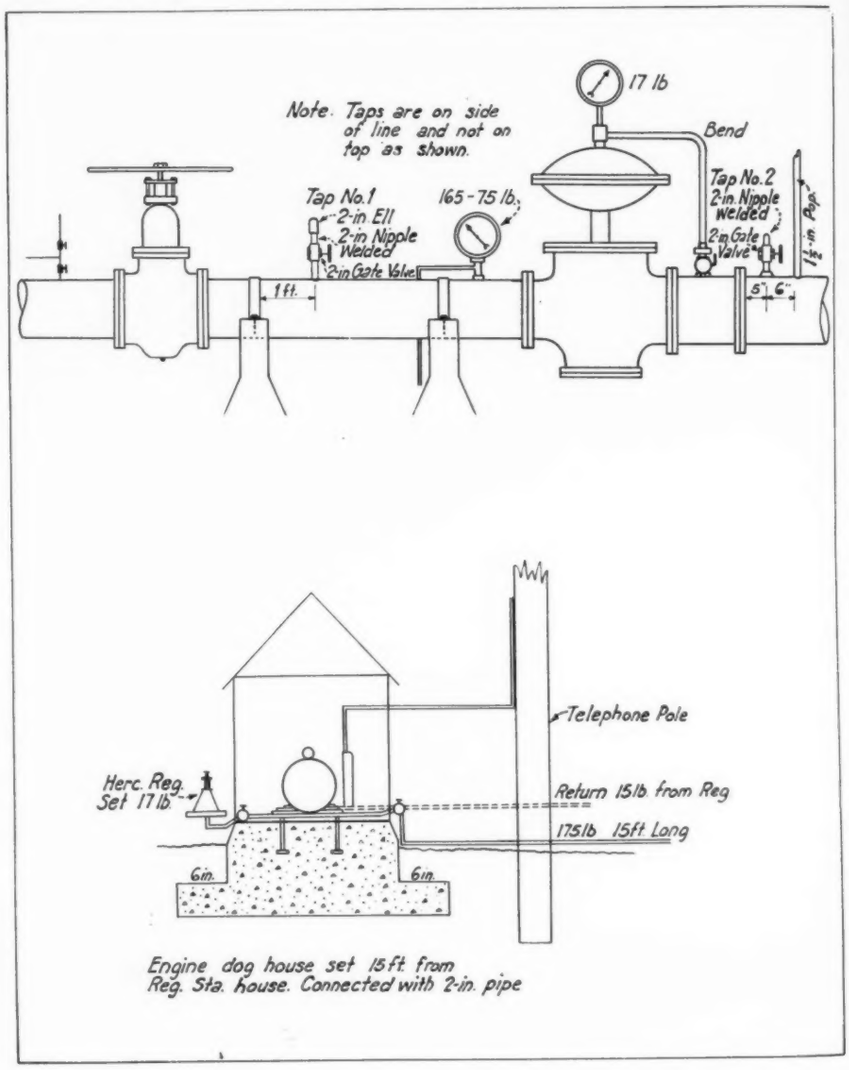

Fig. 4. Diagram of Hoskins Mound regulator station

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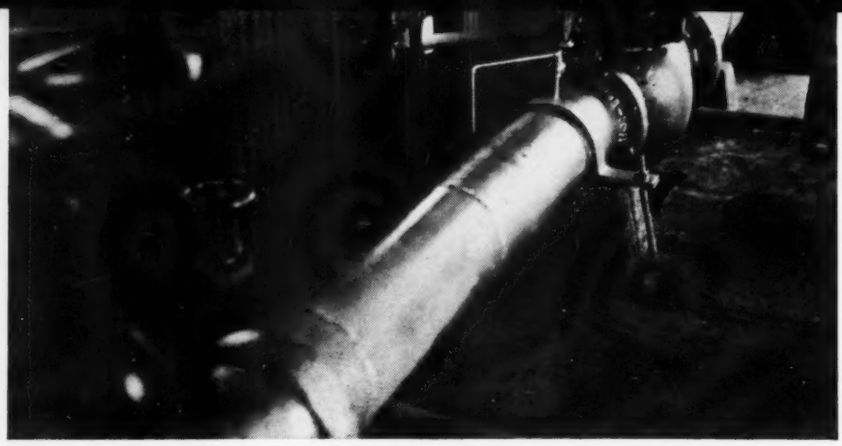


Fig. 5. This illustration shows the 2-in. by-pass connection around the regulator

Although this cathodic protection unit is still in the process of being perfected, it seems to be of enough promise to assure us that ample protection can be had at no fuel cost whatever.

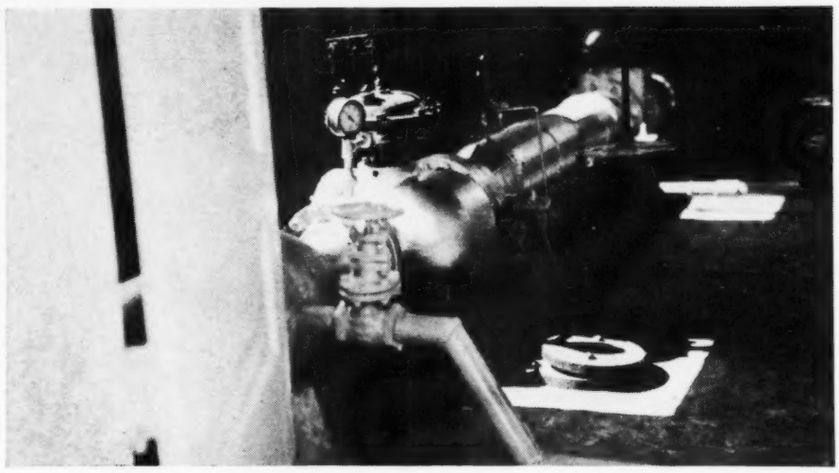


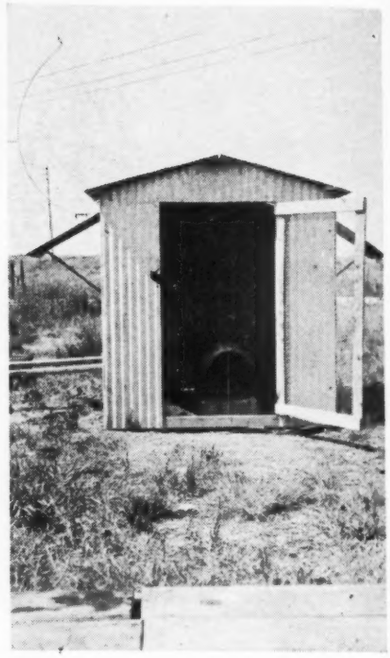
Fig. 6. Showing the 2-in. by-pass connections on 12¾-in. service line not in service

gate in the right of the picture while the discharge is clearly shown to the left of the 12¾-in. regulator.

Fig. 7 shows the house constructed over the unit and the equipment inside. A piece of sheet metal was placed over the commutator of the generator as this faces the door of the house and moisture could enter through the wire construction with ease. This metal cover can be seen in the photograph. The first house over this machine was a small dog-house that just fitted over the equipment. This was very unsatisfactory for many reasons. First, when it was raining it was impossible to work on the machine or oil it and, second, should a leak occur in the packing glands there was great danger of an explosion. The district foreman for the Houston Pipe Line Company owned a dog who did not require inspection during rainstorms and who was not apt to "blow up" from sparking at the commutator so he fell heir to the first house and this winter it is hoped that he will be grateful for our mistake.

Since this unit was placed in operation many observations have been made of the earth potential on about 1800 ft. of coated 16-in. line through the plant of the Freeport Sulphur Company at Hoskins Mound. In the potential chart (Fig. 8) it will be seen that the curve "A," which was the bad positive or electrical discharge condition, before placing the unit in operation was reduced to curve "B" by the first attempt and further to curve "C" by the installation of the new anode, while the final curve "D" represents the potential measured after the unit had been in operation two weeks.

Fig. 7. (Below)—Engine in house. Connection to feeder system on telephone poles also shown



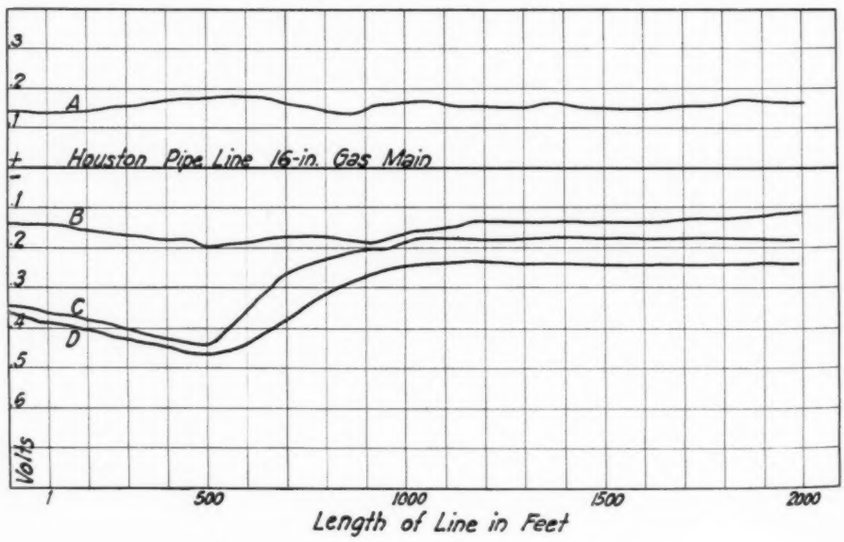


Fig. 8. Earth potential curve

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Oil-World Exposition Proving Great Success

THE Oil-World Exposition opened on Monday, October 11th, in the new Coliseum at Houston, Texas, with a display of oil tools and machinery in far greater number and variety than at any previous oil show held in that city. The equipment presented by manufacturers from all over the country and from foreign nations includes instruments, tools, machinery, devices and specialties for exploration, drilling, production, refining, natural gasoline manufacture, pipe line and transportation and many of the allied operations. Visitors from all parts of the United States and from most of the foreign countries where oil is produced were on hand at the formal opening. With approximately 60,000 tickets sold in advance of the opening, the estimated number of oil men expected to visit the event during the week exceeded 100,000 at the time of going to press.

Consistent with the claims made by the board of directors of the Oil-World Exposition, the educational features, as regards both equipment and operating methods, were stressed. The meetings scheduled, therefore, were made to include treatments of modern methods in overcoming problems encountered in present-day field and plant operations.

Despite the great size of the new Coliseum, which was opened with the Houston Oil Show, a tent had to be erected to accommodate the many exhibits for which there was not enough room in the main building. Between these two display areas were situated the derricks and heavy machinery set up for operation. Complete rigs were installed in all but one of the derricks. Many of the latest devices for drilling control were installed on the rigs, and construction details of some of the drilling control devices were arranged for closer inspection in the inside booths.

The date of the next Oil-World Exposition in Houston has been decided for either April or May, 1939, by a decision of the board of directors of the Oil-World Exposition, Inc.

In addition to providing a complete coverage of all type of equipment used for the many branches of the petroleum industry, the displays were set up in a most attractive manner, the booth decorations making an impressive appearance. Moreover, adequate attention was given the design of the exhibits to facilitate the inspection of equipment and make it possible to examine both the construction and operation of the tools and machinery shown.

Keen interest in the golf tournament scheduled for Wednesday at the Brae-Burn Country Club was shown upon the arrival of all the prospective players; and the trophy displayed in a bank window caused the oil industry champions to get in a few practice swings during the first few days. Numerous additional prizes have been provided by various oil-tool manufacturers. Other entertainment features arranged during the show are receiving their full share of interest, those in attendance taking advantage of the seat reservations for wrestling matches and football game.

The importance of giving the student a practical knowledge of the equipment that some day he will have to use was recognized in planning the educational features of the show.

The problems confronting the petroleum industry from a legislative viewpoint are many and varied and several of these are being given careful study and discussion at the annual meeting of the Independent Petroleum Association of America being held in Houston during the Exposition. The accumulation and correlation of data that will be presented before the committees in Congress during the coming year are being given intelligent consideration, and as the membership of the association is from producing areas throughout the country, every condition can be considered with broad understanding.

The speech by Secretary of Interior Harold Ickes at the annual banquet of the I.P.A.A. is attracting attention and indications are that the dinner will be well attended. The various dinners and banquets are receiving excellent attendance and special interest on the part of oil men from foreign countries and manufacturers is being shown in the oil equipment export meeting and dinner.

The study given to new equipment design has been an outstanding feature demonstrated by the Oil-World Exposition. The industry has gone scientific and both the manufacturers and the oil men are making use of the technical developments in equipment and methods to obtain more efficient and economical results. Improvements are evident in both standard tools and machinery, as well as in the specialties, many of which are here being displayed for the first time. The operator is taking advantage of every opportunity to learn about the newest tools and equipment and the latest methods of operation.

Aerial View of Oil-World Exposition buildings and grounds

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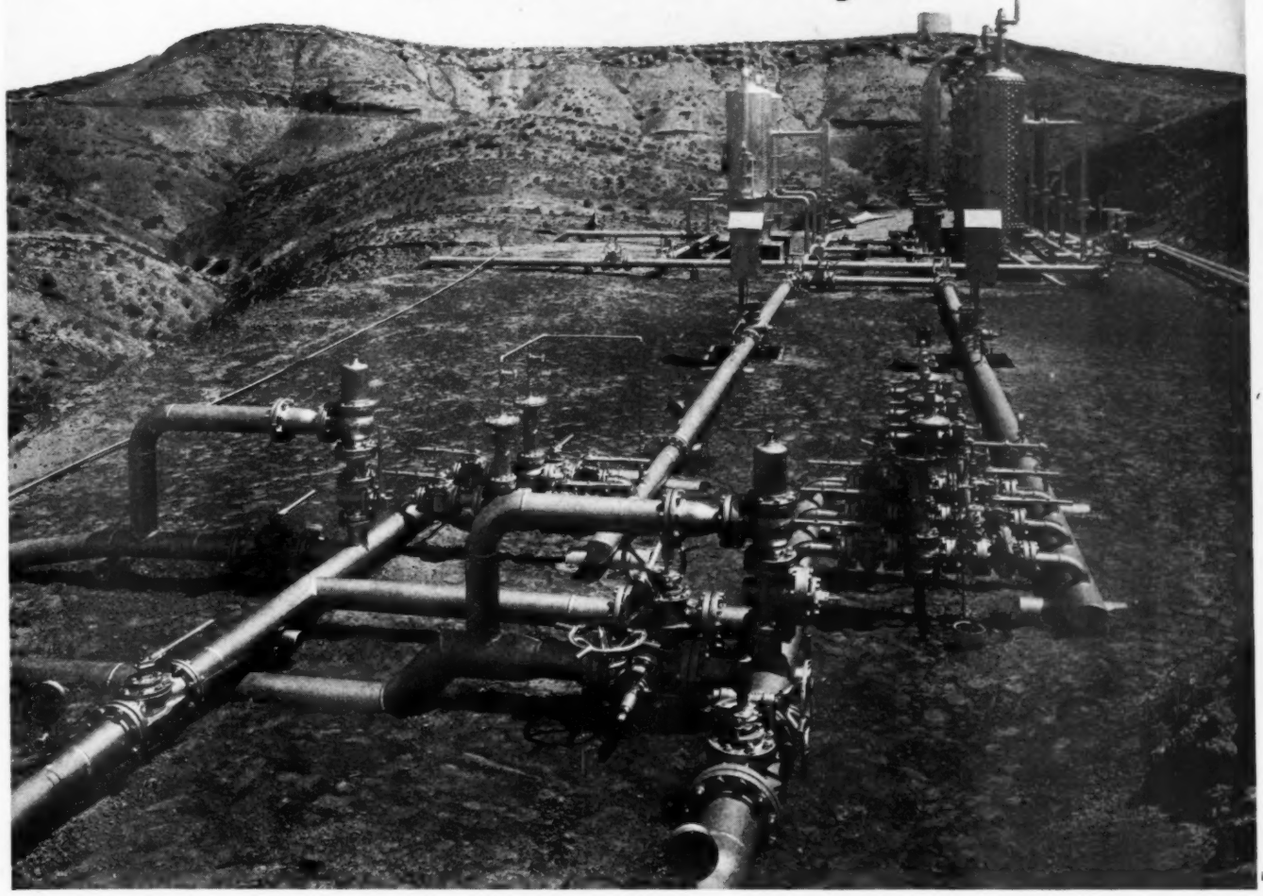

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Repairing Leaks in Ground-Joint Flanges

By W. J. GRISSETT[1]

SERIOUS leaks in ground-joint flanges easily can be repaired by inserting a ring gasket cut from any suitable flat material.

The diameter of the center hole in the gasket should be slighly smaller than the inside diameter of the flange, and the gasket's outer dimension should equal the diameter of the circle formed by the flange bolts. If preferred it may be made large enough for flange-bolt holes to be punched. Either way the gasket is cut, the flange bolts will prevent its slipping while the flange is being tightened. Flanges whose joints are pitted so badly that regrinding is impractical can have their usefulness extended indefinitely by this method.

Another method, often used by the writer, is the caulking of flanges. This method has the advantage of enabling the making of repairs to flanges while under pressure, without interfering with the operation of the pipe line. The only tools needed are a hammer and three narrow chisels thin enough to pass easily between the faces, or rings, of the flange. The chisels have long bevels on one side and short bevels on the other; one chisel has a square point as shown at A-1 in Fig. A, and the other two have oblique points sloped opposite as shown at A-2 and A-3. The oblique chisels are used to caulk behind the flange bolts.

Having found the leak, and with all flange bolts as tight as practicable, the point of the chisel is placed on the bronze, or female, seat of the flange close to where the bronze seat is attached to the flange body and at the point of the leak. (See Fig. B). Light hammer blows on the chisel will drive the bronze tightly against the male seat of the flange, thus making a joint and stopping the leak. This method has a high percentage of success and is found effective even on flanges on high-pressure lines.

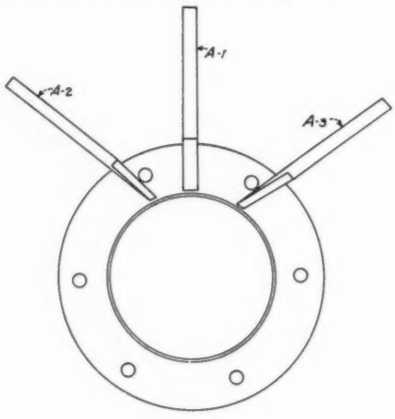


Fig. A

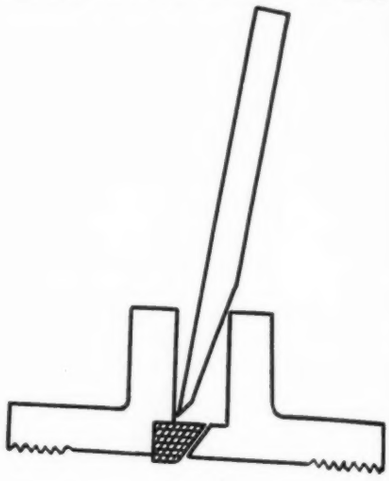


Fig. B

[1]Big Lake Oil Company, Texon, Texas.

Sound Motion Picture Presents First Visualization of Heat

REALIZING that today, as never before, industrial advancement hinges to a large extent upon the more effective utilization of heat, industry is constantly striving toward perfection in the art and science of heat conservation. The latest important contribution towards this goal is the sound motion picture "Heat and Its Control" produced by Johns-Manville.

The importance of this contribution lies in the fact that this talkie makes available for the first time an actual visualization of what heat is, and the story of its use and methods of conservation.

The first official showing of "Heat and Its Control" was attended by 150 representatives of the industrial and technical press at New York City.

At the same time, Johns-Manville announced publication of an authoritative handbook "Heat" that supplements the movie, covering approximately the same ground in greater detail.

"Heat and Its Control" filmed by Caravel Films, Inc., visualizes the story of heat from the time man worshipped the sun, to present day methods of development and manufacture of heat conservation materials.

Actual laboratory demonstrations, animated drawings and shadowgraphs are used in the picture to help visualize the nature of heat and to illustrate heat transfer by radiation, convection, and conduction. Molecular activity, the passage of heat through a boiler wall, and how insulating materials resist the passage of heat likewise are illustrated by animated drawings.

Other animated drawings and laboratory demonstrations are used to explain the phenomenon of thermal conductivity and the reasons for the vast difference in the conductivity of various substances. Radiant heat energy also is visualized in the same effective manner.

An interesting series of shadowgraphs enables one actually to see the air currents set up by heat in so-called dead-air spaces as well as to see the convection currents set up by flames, heated pipes, and the like.

Man's first efforts toward the scientific conservation of heat, the activity in a modern heat research laboratory, how new materials for conserving heat are developed, how they are manufactured, and methods of utilizing these materials are pictured in detail.

More than 500 scenes are incorporated in "Heat and Its Control", including "shots" of bleak arctic wastes, of sunbaked deserts, and scenes depicting milestones in the story of man's attainment of mastery over heat, such as Watt's invention of the first practical steam engine.

In photographing the latter, a replica of the kitchen where Watt worked, as well as a full-sized model of his first steam engine were constructed. Many other historical "sets" also were built for "Heat and Its Control."

The book "Heat", while covering the same ground as the sound movie, does so in considerably greater detail.

Divided into five chapters for easy reference, it covers the history of heat from ancient times; the discovery of what heat is with a full explanation of its nature; the science of heat conservation; the modern materials available for conserving heat; lastly, illustrations of the specific use of these materials in individual industries.

Number of Oil Refineries Declines But Capacity Continues to Increase

THE total number of completed petroleum refineries in the United States declined materially in 1936, but the total capacity to process crude oil and to crack unfinished oils continued to increase. Approximately 60 plants were dismantled or removed from the list as being worthless except for junk. These facts were ascertained from the canvass of refinery capacity made by the U. S. Bureau of Mines, Department of the Interior, as of January 1, 1937, the details of which will be published later as an Information Circular.

The number of operating refineries remained virtually unchanged in 1936, there being 423 on January 1, 1937, compared with 422 on January 1, 1936. The large decrease in number of completed refineries affected chiefly the idle plants, which had reached a peak of 210 at the beginning of 1936. On January 1, 1937, only 149 idle plants were considered to be worth reconditioning, a decline of 61 from the previous year. Approximately half of the "casualties" were in the East Texas field, where only 14 plants were operating on January 1, 1937, out of the 80 or more constructed. About a dozen plants have been dismantled in the East Texas field since the first of this year, but these were retained in the list so the figures would be comparable from year to year. Refineries are closed down when they cannot be operated at a profit, then dismantled as the sources of crude dry up. Ordinarily a plant is closed down several years before the owners become convinced that the small salvage value outweighs the future possibilities; however, in the East Texas field it did not take some refiners long to realize that the possibilities for the return of the cheap crude days of 1931-1934 were slim, consequently the average shut-down period in that field has been short.

The total capacity of the completed plants on January 1, 1937, was 4,294,881 bbl. of crude oil daily. This does not mean that that much crude could have been run at that time as most of the capacity of the inoperative plants, 328,265 bbl., could not be used without considerable modernization. Furthermore, much of the shell-still capacity of the operating plants, estimated as about 1,500,000 bbl., probably is in poor condition.

Of vital interest today is the amount of excess refining capacity. Some large companies are admittedly operating at capacity, and the question arises as to how the increases in gasoline and light fuel oil consumption will be met. The highest daily average crude runs around the first of the year were approximately 3,100,000 bbl., indicating an "excess" capacity of about 867,000 barrels. Some of this "excess" is represented in the overstatements of capacity by the smaller companies and some in the unusable capacity at plants without sufficient crude or markets for products. Most of it, however, probably is shell-still capacity that can be operated only at a sacrifice in yields of finished products. How much of the stand-by shell-still capacity was actually operating on January 1, 1937, is not known. That more of the stand-by capacity has been used in the past year is indicated in the failure to maintain gasoline yields, although this may have resulted from deliberately increasing fuel-oil yields or from running heavier crudes. Doubtless crude runs could be raised even above the high levels now prevailing as considerable pipe-still and cracking capacity now operating on unfinished oils could be converted to crude. Actually considerable cracking capacity has been converted to run on crude oil much after the manner of the new combination units. The crude-oil capacity of the converted cracking units on January 1, 1937, was 217,885 bbl.; that of combination units was 432,300 barrels. Comparable data for prior years are not available, but both figures are believed to represent substantial increases over the preceding year. As further insurance against demand outstripping crude-oil capacity is the material increase in construction and modernization, equipment companies being busier in 1936 and 1937 than at any time since 1929, possibly since 1920.

The capacity of the operating plants in California, the leading district, remained practically unchanged in 1936 but the East Coast, Indiana-Illinois, and Texas Gulf Coast districts made material gains. The growth in refinery activity in the Texas Gulf Coast in recent years has been outstanding; although it has only about 30 plants, it virtually matches California in capacity and is far ahead of that state in crude runs. The only other district in which crude runs have increased materially in recent years is Indiana-Illinois, although in this case the dominant factor has been one of increased demand within the district rather than of location as is the case with the Texas Gulf Coast.

The capacity of the 74 "complete" plants operating on January 1, 1937, continued to represent nearly half the total, although the capacity of skimming plants registered a larger increase in 1936. This was primarily because most of the combination capacity was classed as "skimming." The increased demand for asphalt possibly had something to do with a material increase in the capacity of "skimming and asphalt" (S&A) plants.

The superiority of the pipe still over the shell still as a distilling unit continued to assert itself with the result that the number of pipe stills increased from 727 on January 1, 1936, to 757 on January 1, 1937, whereas many shell stills were junked. The number of pipe stills operating on crude oil showed little change, consequently the net increase swelled the number operating on unfinished oils, for example, topped crude from shell stills. The capacity of the pipe stills operating on crude oil on January 1, 1937, was 2,202,335 barrels. This was equivalent to approximately 73 percent of daily average crude runs of that date, compared with 76 percent a year ago.

The trends in cracking capacities in 1936 were the same as in 1934 and 1935, that is, the capacities operating and under construction increased but the idle capacity declined. The capacity of the operating units, which includes the cracking capacity of combination units, increased from 1,994,868 bbl. on January 1, 1936, to 2,077,325 bbl. on January 1, 1937, or four percent. As the charge to cracking stills increased 19 percent in that period, it follows that an increase in the operating ratio outweighed the comparatively small gain in capacity. That the operating ratio for cracking units (80 percent) is approaching the maximum is indicated in the large gain in capacity under construction — 30,450 bbl. on January 1, 1936, to 138,220 bbl. on January 1, 1937. The present amount of new construction in cracking compares with the boom days of 1929 and 1930.

The East Coast continued to lead in cracking capacity, although the Texas Gulf Coast will be in first place as soon as its current building program is completed. The largest increases in capacity in 1936 were registered in the Texas Gulf Coast, Indiana-Illinois, and California districts.

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

"Did you hear about Mae West fainting in the Grand Central Station the other night?"

"No, what happened?"

"It took six men to carry her out."

"Six!"

"Yes, three-a-breast."

* * *

"How'd you get along with your wife in that fight the other night?"

"Aw, she came crawling to me on her knees."

"Yeah? What did she say?"

"Come out from under that bed, you coward!"

* * *

"You'll have to see my secretary for an appointment."

"I did, but she's booked up two weeks."

* * *

He: Why wait until we get home to tell me whether you'll marry me or not?"

She: I'm scared; this is the exact spot where my father proposed to my mother.

He: What about it?

She: Well, on the way home, the horse ran away and father was killed.

* * *

An Epitaph

Here lies the body of Roderick Souse.
His shoes were found in a neighbors house.

* * *

Joshua: Did you know that Jonah was three days in the stomach of a whale?

Erastus: That's nothing. My uncle was longer than that in the stomach of a crocodile.

Joshua: How long?

Erastus: He's there yet.

* * *

Traveler: My, the air up in these mountains is surely great, isn't it?

Old Mountaineer: Well, jes' fair to middlin', stranger, jes' fair to middlin'. 'Taint nothin' compared to like it wuz back in Cleveland's a'ministrashun.

* * *

Mrs. Chubb: I must say dances today are quite different from what they were when I was a young lady.

Mrs. Gabley: Yes, I remember, too. In those days when a young girl had nothing to wear she stayed at home.

Henry: What would you do, dear, if I should die?

Mrs. Peck: I should go nearly crazy.

Henry: Would you marry again?

Mrs. Peck: I said *nearly* crazy.

* * *

Doctor: Now, Miss Elsie, where shall I vaccinate you?

Elsie: Oh, anywhere, Doc; it's bound to show.

* * *

Agent Slick: Well, what do you think of our little town?

Prospective Buyer Tyte: Frankly, this is the first cemetery I ever saw with street lights and fireplugs.

* * *

Jimmy: Too bad about Alford wrecking his car last night, especially with his girl along.

Norman: Did something go wrong with his car?

Jimmy: Yes, too much play at the wheel.

* * *

Rastus: Mandy, after I dies, I wish you'd marry Deacon Shorter.

Mandy: Why so, Rastus?

Rastus: Well, Mandy, I'll tell you de truff. Deacon Shorter trimmed me on a mule trade once.

* * *

Judge Sharp: Just where did the defendant's auto hit you, Miss?

Sally: Well, Your Honor, if I had been wearing a license plate it would have been badly damaged.

* * *

Mrs. Tenderfoot: Will the operation be dangerous, doctor?

Dr. Slicem: Now don't you worry about that. You can't buy a dangerous operation for $50.

* * *

The householder was awakened by someone apparently trying to fit a key into the front door of the house. Looking out of the window he saw that it was his neighbor, apparently about 2½ sheets to the wind.

"Go away, you fool," cried the householder. "You're trying to get into the wrong house."

"Shay," mumbled the neighbor, "whaddaya mean, wrong house? You're lookin' out o' the wrong window."

* * *

The old-time cattle thief now has a grandson who merely pinches calves.

Have you heard the Old Maid's Prayer: "Now I lay me down to sleep—Dammit!"

* * *

"What did Marc Anthony say to Cleopatra when he found that she had no bathroom in her palace?"

He said, "Why, Cleo, this is uncanny."

* * *

"Ah, Watson, I see you still have on your winter underwear?"

"Marvelous, Holmes, how did you ever deduce that?"

"Elementary, my dear Watson, you've forgotten to put on your pants."

* * *

Then there is the fan dancer who was arrested for no gauze at all.

* * *

Instruction Needed Only

Dr. Chargem: My boy, I'm afraid your father will have to lose his right hand.

Son: Gee, Doc, how soon will he be able to learn to sign checks with his left hand?

Dr. Chargem: Just as soon as I can teach him.

* * *

A city and a chorus girl
Are much alike, 'tis true;
A city's built with outskirts,
A chorus girl is too.

* * *

The trial had reached a stage where the defendant's wife was allowed to testify in an attempt to establish an alibi.

"You are positive you know where your husband was on the night the crime was committed?" asked the prosecutor.

"Well, all I can say," replied the good woman, "is that if I didn't, then I busted a good rolling-pin over the head of an innocent man."

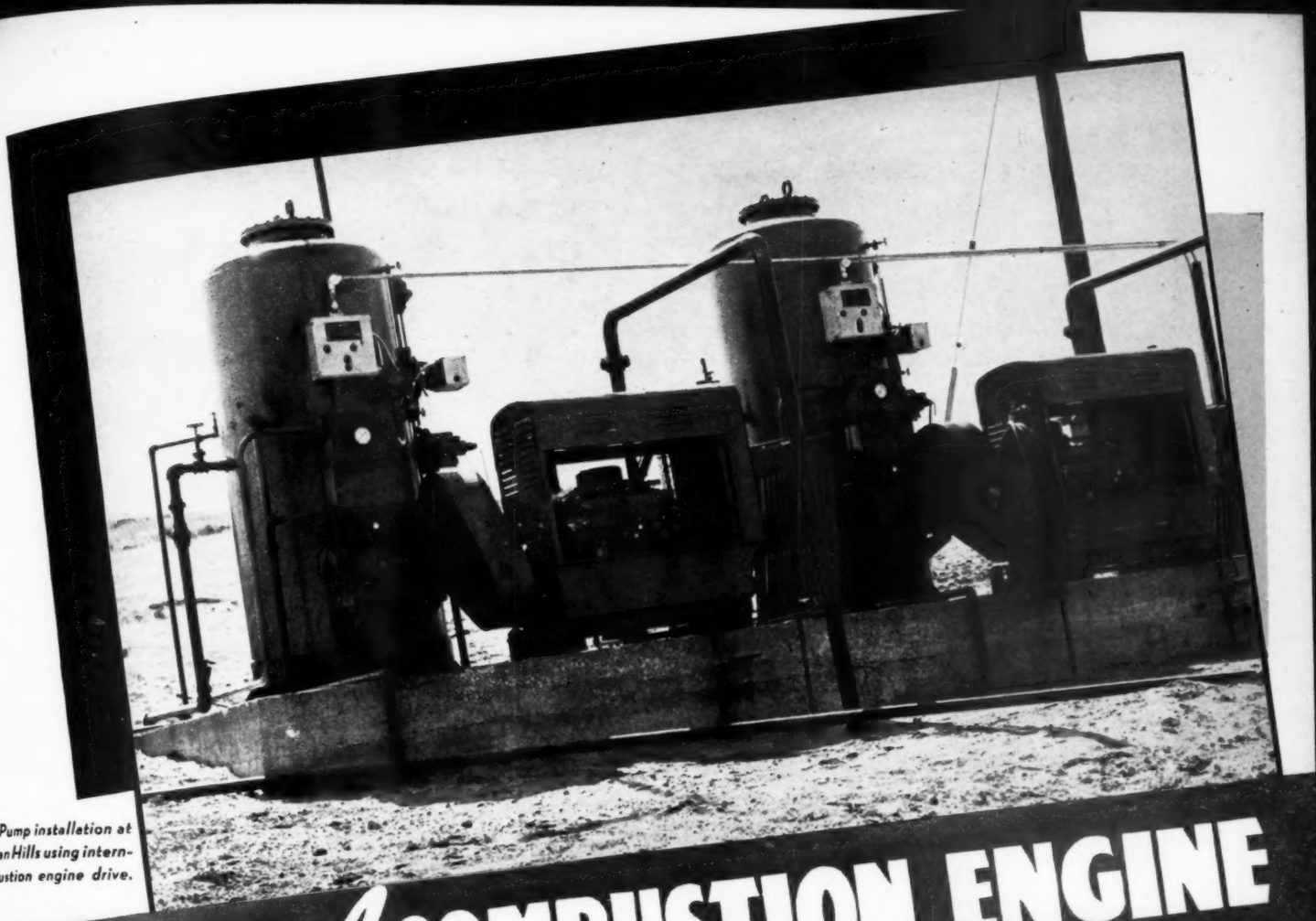
* * *

The funeral procession moved slowly along the village street. One of the townspeople stepped up to a watcher, and asked, "Who're they buryin'?"

"Old Jeb Smith."

"Jeb Smith, eh? Why, is Jeb dead?"

"Naw, they're just rehearsin' with him."



Kobe Pump installation at ...tlemen Hills using intern... ...combustion engine drive.

Internal COMBUSTION ENGINE OR ELECTRIC MOTOR DRIVE

KOBE

Kobe All-Purpose Pumps are available with all standard types of internal combustion engines, as well as with electric motor drive. The value of this flexibility in motive power will be readily apparent to operators in fields where specific types of prime movers, or certain fuels, offer greater utility; or where electric power is not available.

These various drives are completely interchangeable; and the change can be made in the field without any important modifications in existing installations. Complete information will be supplied on request without obligation.

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Running Tour
WITH MEN IN THE INDUSTRY

R. A. PORTER, of the purchasing department of the Standard Oil Company of California, Los Angeles, California, is spending his vacation looking over the Mid-Continent fields.

PETER P. GREGORY, Iraan, Texas, chairman of the Yates Pool Engineering Committee, although retaining his present position, will be available in the future as a consulting engineer, he announces. He plans to work on proration, conservation, and evaluation problems in fields other than the Yates pool. Gregory, prior to accepting his present position in 1930, has at various times been connected with the Shell Oil Company, the Union Oil Company, and the Humble Oil and Refining Company. He is a graduate of the University of California in Petroleum Engineering.

P. P. GREGORY

PROF. H. A. EVERETT of the Pennsylvania State College, State College, Pennsylvania, attended the world conference on lubrication in London, England, October 13, 14, and 15.

L. F. WATSON, of the gas division of the C.C.M.O. Company's engineering department, has been transferred from Fellows to Ventura, California.

JOSEPH W. BOYLE, official of the Asiatic Petroleum Company and the Mosul Oilfields, Ltd., has returned to his headquarters in London, England, following a business trip to the United States and Venezuela.

T. E. SWIGART, who has been vice-president in charge of the Gulf Coast district for the Shell Petroleum Corporation, making his headquarters at Houston, Texas, has been transferred to the executive offices of the company at St. Louis, Missouri. **A. J. GALLOWAY,** Tulsa, Oklahoma, vice-president in the Mid-Continent district, goes to Houston to take over Swigart's work. He will be vice-president in charge of the Gulf Coast district. **RALPH B. ROARK,** Tulsa, production manager of the Kansas-Oklahoma-Panhandle district, has been promoted to vice-president in the Mid-Continent district. His position as production manager has been taken over by **R. W. BOND,** who has been division manager in Kansas.

J. F. "DOC" McMURRAY, a veteran of 36 years' service with the Ohio Oil Company, died recently at his home in the Dry Creek field of Carbon County, Montana. He had been field superintendent for the last four years. "Doc" McMurray was well known in the Rocky Mountain area, having been stationed in various Wyoming fields prior to going to Montana.

H. N. (BUD) SEEVERS, geologist for Atlantic Refining Company for a number of years, is resigning to accept a position with the Shasta Oil Company and will be in charge of the latter's operations in the Corpus Christi area.

E. P. JONES, independent operator and drilling contractor, has moved his headquarters from San Antonio to Houston, Texas.

WILLIAM H. CARSON, acting director of the School of Petroleum Engineering, University of Oklahoma, Norman, recently was made dean of the college of engineering. He succeeds **DR. J. H. FELGAR,** who was forced to resign because of poor health.

LAMAR LUNT, petroleum engineer with the Gulf Oil Corporation, has resigned to accept a position as district engineer with the Gas Lift Corporation. His headquarters will be Midland, Texas.

NELSON DICKERMAN, New York, recently was appointed vice-president of the Amiranian Oil Company and the Inland Exploration Co.

G. H. MURRAY, formerly chief petroleum engineer for the Shell Petroleum Corporation, is now a member of the staff of the Schlumberger Well Surveying Corporation, Houston, Texas.

CAMPBELL M. HUNTER, London, England, president of the Hunter Valley Oil Company, was a recent business visitor to Calgary, Alberta, Canada.

FLOYD OHILGER, manager of the Arabian oil fields of the California-Texas Oil Company, Ltd., has returned to Arabia following a visit to the London, England, offices of the company.

T. COHN, formerly refinery manager of Coal and Allied Industries, Ltd., Seaham Harbour, England, has been appointed to the technical staff of Kern River Oilfields of California, Ltd.

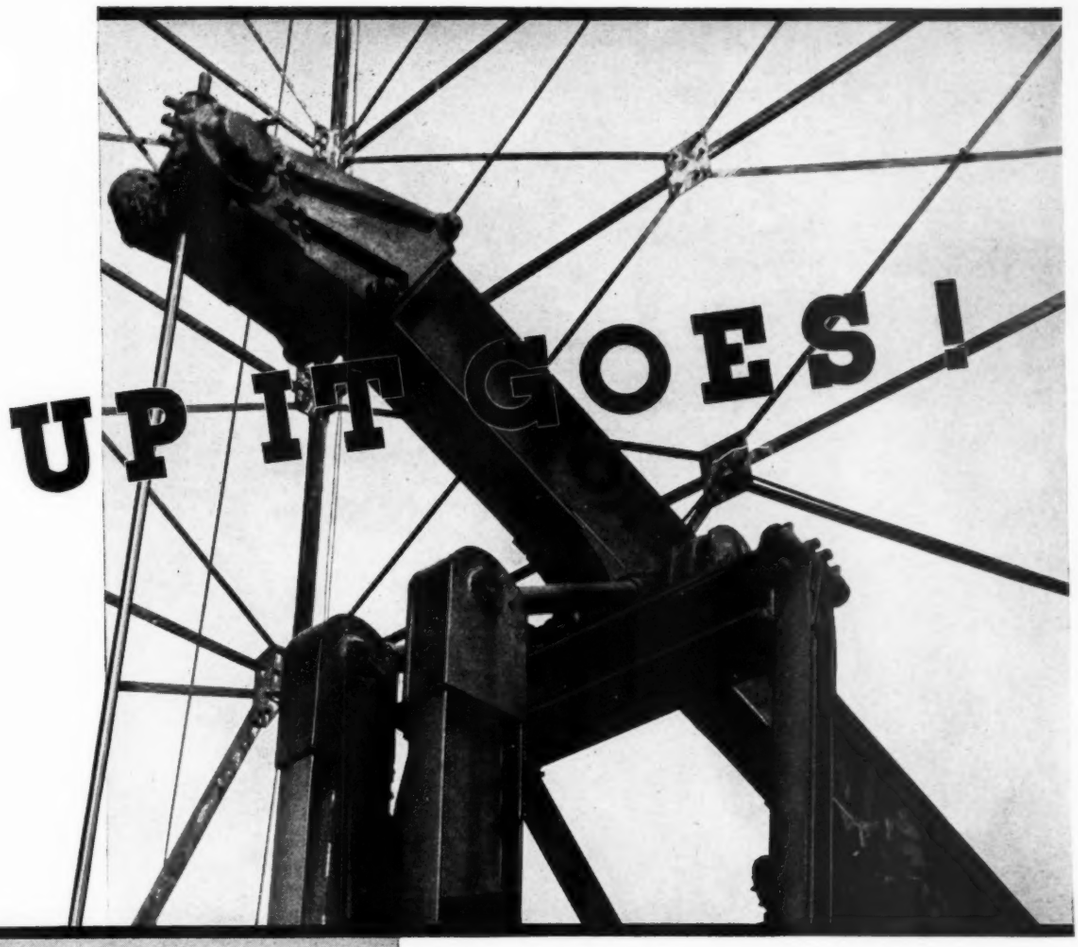
C. F. FRANCES, London, England, recently was placed in charge of European purchases for the Standard Oil Company of California, Ltd.

ALEXANDER MORRIS, consulting petroleum engineer of Tulsa, Oklahoma, who specializes in old-field tax accounting and all phases of evaluation work, on which he is an authority, was a recent visitor in Dallas, Texas.

A. B. STEVENS, who has been associate professor of petroleum engineering at Texas A. & M. College, College Station, Texas, has been made a full professor in the department. **J. P. HAYS,** who for the past three years has been district petroleum engineer for the Shell Petroleum Corporation, working in the Gulf Coast areas of Texas and Louisiana, has been added to the teaching staff as an associate professor.

W. G. PRINCE, field production superintendent for the Stanolind Oil and Gas Company at Lake Charles Louisiana, resigned recently to accept a similar position with Texas Crusader Oil, Inc., Houston, Texas.

M. J. LEAHY, consulting engineer and chemist, has moved his offices to 718 Insurance Building, Fort Worth, Texas.



PARKERSBURG *Long Stroke* PUMPING UNITS

●

THE PARKERSBURG RIG & REEL CO.
Parkersburg, West Va.
HOUSTON · DALLAS · TULSA · LOS ANGELES · NEW YORK
Branches In All Active Fields

● One after another, with clock-like regularity, reports are coming in of increased production with Parkersburg Long Stroke Pumping Units. One of the more recent reports tells a story that should make *any* operator stop, look and investigate before buying new pumping equipment.

On this particular well the operator installed a Long Stroke Pumping Unit and production of gas and oil went up to the tune of $700.00 per month. Gas increased from 4,000′ to 47,000′ per day and the net increase in oil production amounted to 38 barrels per day. Moreover there will be another nice profit in the savings due to less down time and fewer rod jobs. Is it any wonder that operators are so enthusiastic about their Parkersburg Long Stroke Pumping Units?

Perhaps *you* are passing up a chance to increase your production. If you are it's money out of your *own* pocket and deserves attention *now*. Begin by calling your nearest Parkersburg representative. He will be glad to give you full details.

MACHINERY and EQUIPMENT

Atlas Supply Company's Pumping Unit No. 507

ATLAS Supply Company's new pumping unit No. 507, for pumping shallow wells, is a new addition to broaden the scope of their line of pumping units. The same design and welded construction of the larger units is embodied in this smaller model.

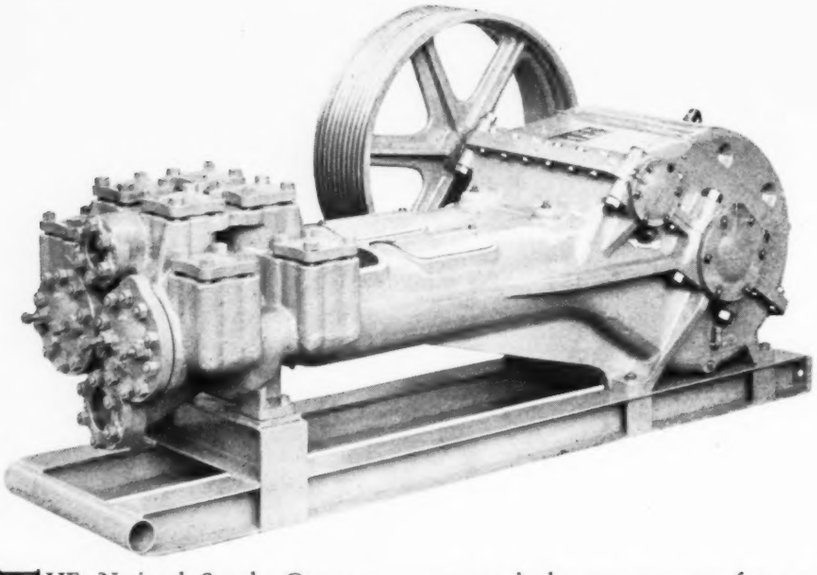
A double-reduction, helical-geared reducer, with an A.P.I. rating of 5 hp. at 20 s.p.m. and a peak torque rating of 25,000 in-lb. is used. The reduction ratio is 31.8 to 1. The twin cranks have strokes of 14 in., 21.5 in., and 29 inches.

Both rotary and beam type counterbalance weights are used and weights may be added at either point. This makes the machine unusually adaptable to a wide range of speeds, the makers state.

The 12-in. walking beam has an A.P.I. rating of 6375 lb. with working centers of eight ft. from pitman to well. The removable horsehead allows ample well clearance for servicing.

The extended base illustrated is standard, making the machine suitable for either electric motor or multi-cylinder engine prime-mover.

Ideal Type D-50 Duplex Pump



THE National Supply Company, Toledo, Ohio, recently introduced a new duplex power pump for general oil field work, especially oil gathering, water, and slush service. This is designated as the Ideal Type D-50, and has a maximum fluid cylinder bore of 5 in. with a stroke of 10 inches. The maximum working pressure of the fluid end is 1000 lb., and the maximum rated hydraulic hp. is 50 at 60 revolutions per minute.

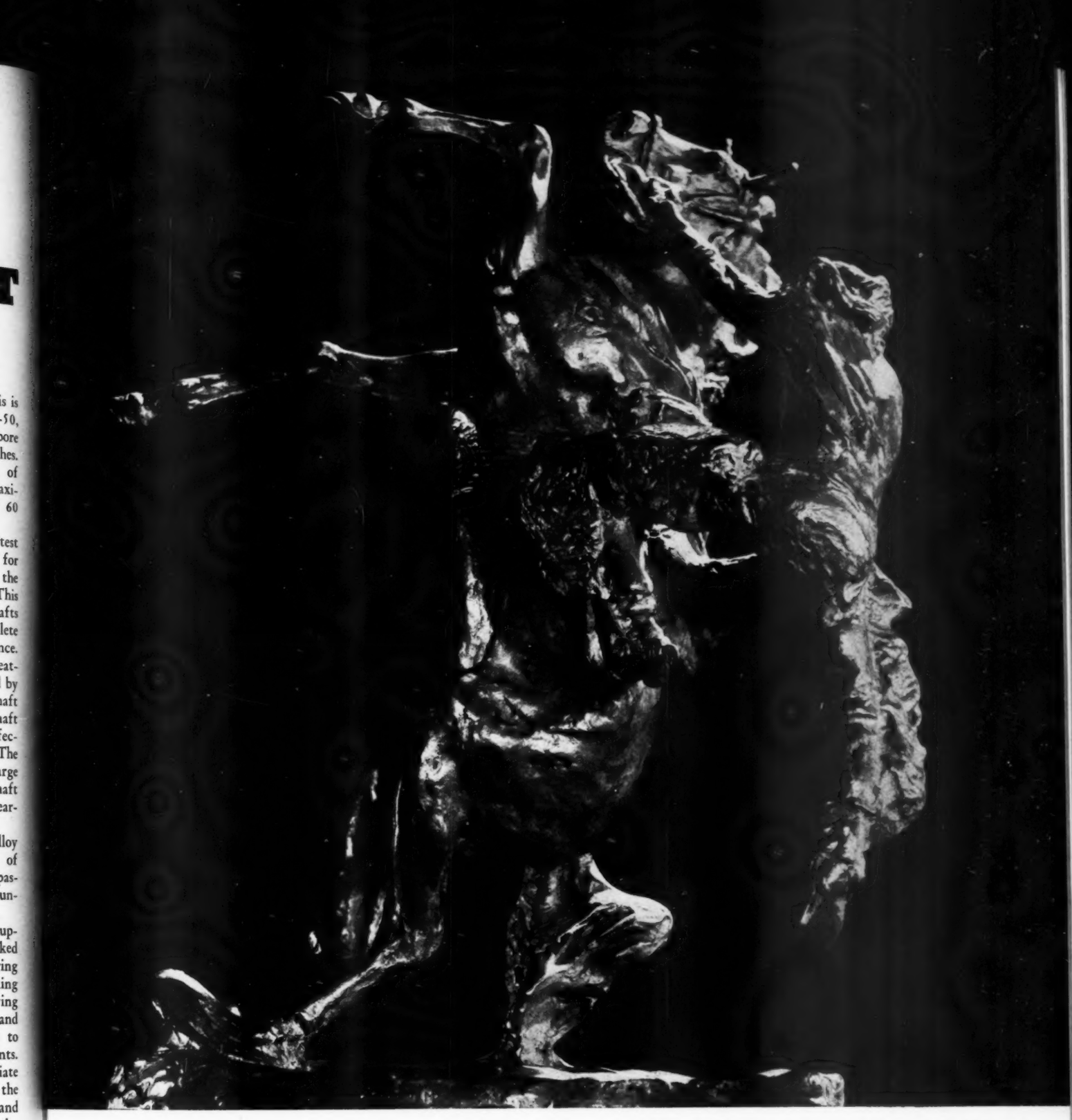
The frame is a two-piece high-test iron casting, heavily ribbed for strength and rigidity and split at the pinion and crank-shaft bearings. This allows the installation of the shafts with gears and bearings as complete units, adding to operating convenience.

The gear and pinion are heat-treated Sykes herringbone generated by National. The pinion and pinion-shaft are forged integrally, and the shaft diameter is left unusually large effectively to minimize deflection. The crankshaft is carried on two large Timken bearings and the pinion shaft on two SKF self-aligning roller bearings.

The fluid end is a one piece alloy iron casting, reinforced at point of greatest stress. Large direct fluid passages and valve openings eliminate unnecessary flow resistance.

Fluid cylinder liners are firmly supported in the cylinder and are packed against fluid leakage by a rubber ring behind the liner collar. This packing can be tightened without removing the cylinder head. Fluid pistons and rods are available in several types to cover all the usual field requirements. The use of alloy steel intermediate rods makes it unnecessary to open the crank-case when changing liners and pistons. Fluid valves of the same design as those on the larger Ideal slush pumps are available for slush service, and bronze or Durabla valves for oil or special water service.

Flood lubrication of a positive and automatic type is used on all working parts, and the crank and pinion bearings are grease-packed through connections easily accessible from the outside of the case. A V-belt drive is regular, although belt, chain, or direct-connected drives can be used. The regular skid mounting consists of two heavy steel H-beams with welded cross members. A platform for engine or motor rails is provided.



† "WHERE THE BEST OF RIDERS QUIT"—by Charles M. Russell

Adapting Art for Industry's Sake

The worthwhile things are those that endure. A statue is chiseled from marble—a painting takes form under the hand of the master—a device beneficial to all mankind is perfected by the engineer. In industry, art is the adaptation of things to the uses of life. ☆ At Axelson the knowledge of generations of chemists, designers and engineers are comprehensively applied to the manufacture of Axelson products. Axelson Pumps and Sucker Rods represent not only artistry of line and finish but the finest working of skilled artisans in every stage of their fabrication. Their perfect performance in the field reflects the cautious practices of careful production. ☆ Axelson Manufacturing Company, P. O. Box 710—Vernon Station, Los Angeles. St. Louis. 50 Church Street, New York City. Tulsa. Mid-Continent and Eastern Distributors: Frick-Reid Supply Corp. Rocky Mountain Distributor: Great Northern Tool & Supply Co.

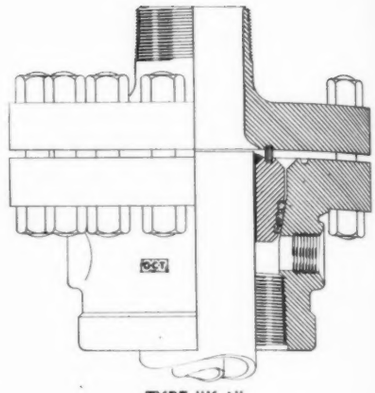
☆ ☆ ☆

† No one has ever portrayed the cowboy and his horse more truthfully than Charles M. Russell. Here the rider quits a fighting horse, which is intent on landing on him. As the horse hits the ground, the cowboy helps to bump the horse's head. As the horse comes up, a grasp of the horn and the rider will be in the saddle again. ☆ This is the first time that permission has been granted for the reproduction of this bronze. A reproduction of this picture, suitable for framing, is available upon request.

AXELSON PUMPS AND SUCKER RODS

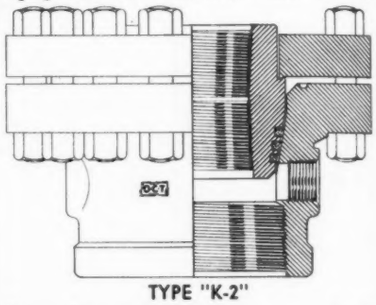
Types "K-1" and "K-2" O-C-T Casingheads

THE O-C-T type "K-1" casinghead shown here is a full open head designed for running welded casing through blowout preventer equipment. The body flange is made to A.P.I. specifications, being provided with a standard A.P.I. ring joint to accommodate A.P.I. flanged blowout preventer equipment. After cementing the casing, blowout preventer equipment is removed and a forged steel casing hanger slips over the casing and seats in the bowl of the body. After taking the stretch in the casing string the casing is then welded to the hanger, which packs off on three rings of hydraulic packing. Casing is then cut off flush with the top of the hanger and a tubinghead adapter flange bolts down on top of a ring joint provided on top of the hanger. Tubinghead adapter flange is available with either threaded or flanged connection. Manufactured in test pressures ranging from 4000 to 10000 pounds.



TYPE "K-1"

The type "K-2" O-C-T casinghead is a full opening head designed for use with blowout preventer equipment to permit drilling and running and landing casing under pressure. Casing is suspended from a forged-steel hanger, which passes through the blowout preventer equipment, and seats in the bowl of the body. After cement has set, blowout preventer equipment is removed and a solid



TYPE "K-2"

flange ring bolts down on top of a lip on the hanger to hold the hanger in the head. Casinghead from the inner string, or tubinghead as the case may be, screws into the top of the hanger. Available in test pressures ranging from 4000 to 10,000 pounds.

Both the "K-1" and the "K-2" casingheads are manufactured by the Oil Center Tool Company, Houston, Texas.

THERE'S PROTECTION IN THE CIRCLE
"STANDARD" LUBRICATORS
are *standard equipment* with those operators who are especially careful about the proper protection of today's modern oil country machinery, such as pumps, engines, compressors, in which they have a real investment. The savings resulting from "STANDARD" Lubricators far more than pay for the lubricators themselves.
AMERICAN LUBRICATOR CO.
First National Bank Building Dallas, Texas
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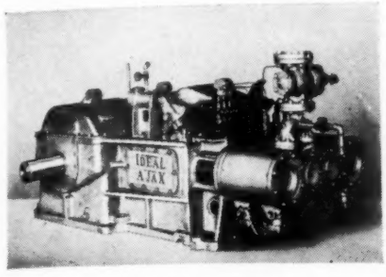
Ajax Drilling Engines

AJAX Iron Works, Corry, Pennsylvania, have announced new horizontal-type twin-cylinder steam engines of an entirely new design. These engines are available in three sizes, 7-in., 8-in., and 9-in. cylinder bore by 8-in.stroke.

For rotary machines these engines offer a compact and economical drive. Direct rotary drive Type "A" (above floor) is a self-contained enclosed unit. The drive to the rotary pinion shaft extension is through an enclosed lubricated chain. A sprocket on the rotary shaft extension gives an emergency drive to or from the drawworks. The Type "B" (below floor drive) allows

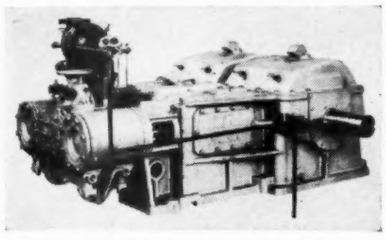
for more clear derrick floor space. For this drive the engine is placed beneath the derrick floor and connected to an extension shaft, which carries two clutch sprockets, one for direct drive to the rotary and one for emergency drive to the drawworks. These drives eliminate the need for a separate stand-by engine that would be idle most of the time. Rotary drive engines are full reversing type with the throttle and



Reversible drive engine

steam kicker controls placed at the driller's regular position.

For driving mud pumps great savings in steam consumption can be obtained by driving power pumps with these small engines, it is stated. As regularly supplied for separate mud pump



9 by 8 pump drive Ideal Ajax twin-cylinder engine

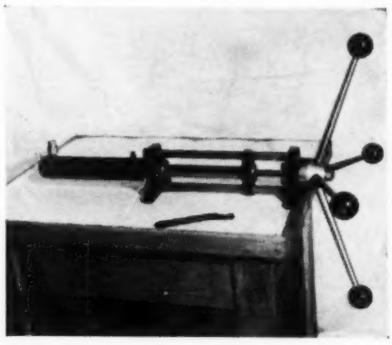
drive the engines are non-reversing, the eccentrics being set to run "under" to give the proper rotation to the pump pinion shaft. The driving sheave may be placed on either the right- or left-hand shaft extension.

Dual engine drive consists of two engines mounted on a skid carrying all clutches, bearings, and couplings. When drilling one engine drives the slush pumps, one drives the rotary, and while making a round trip the power of both engines is available. The driller has control of both engines from his regular position.

Volumetric Mercury Pump

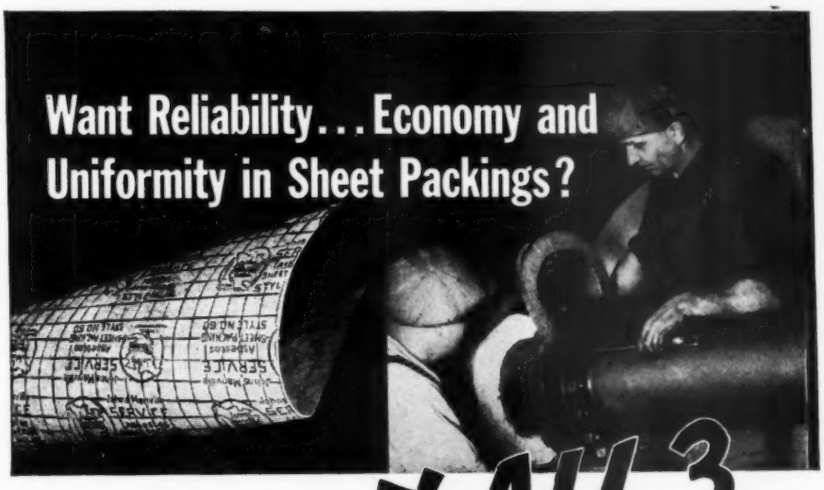
WALTER Ruska & Company, Houston, Texas, have placed on the market a new volumetric mercury pump for laboratory work and petroleum engineering, such as experimentation with oil samples under bottom-hole conditions, pressure treatment of core sections, and accurate volumetric measurements under pressures up to 7000 lb. per sq. inch.

These pumps are screw feed plunger pumps built in two sizes of 100 cc.



and 250 cc. volume displacement. They can be supplied with or without calibration. The calibrated pumps are graduated on the tie rod in cc. A dial on the operating handle is graduated to .01 cc. The steel feed spindle is accurately machined and has a two mm. pitch. The end thrust is taken up by precision Timken roller bearings. The pump can be supplied with a case-hardened or hard chrome-plated plunger. All parts are machined from solid stock, no castings or any welding is used in the construction of the pump. Finish is black enamel and heavy nickel plate.

These new pumps provide an accurate measuring instrument for measuring volumes under pressure or for building pressure in laboratory experiments, the manufacturers state. They meet the demand of petroleum engineering laboratories for a high-pressure unit, it is said. Displacement as small as .01 cc. easily can be read. Walter Ruska & Company, Inc., 6512 Westchester Street, Houston, Texas, will provide further information upon request.



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SHEET PACKING worthy of its name must offer dependability and economy in use on a wide variety of service conditions. And there must be no variation in quality from one shipment to the next.

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Made of selected long-fiber asbestos and special heat-resisting compounds, J-M Service Sheet has a record for outstanding performance on flanges and other parallel surfaces against superheated or saturated steam . . . against gas, oil, air, water, ammonia, certain acids and alkalies.

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"HIGHER-STANDARD" CABLE TOOLS

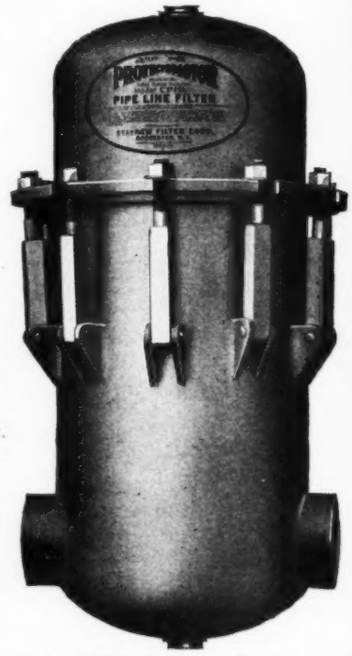
Our experience is yours for the asking... consult us about any cable-tool problem that arises. SPANG & COMPANY, Butler, Pennsylvania.

Protectomotor Pipe Line Filters Feature Non-Corrosive Filter Medium

Model CPH (sectional view) for air or hot gases

GLASTEX, newest filter medium to be used in Protectomotor Radial Fin Construction pipe line filters, is proving of tremendous value in certain industries, its manufacturers state. This latest adaption of glass cloth by the engineers of the Staynew Filter Corporation, Rochester, New York, has opened up an entirely new field of use for Protectomotors in the filtration of high temperature or corrosive liquids and gases. Glastex is resistant to all acids except hydrofluoric, to all alkalis and gases, and to temperatures as high as 600 deg. fahr., it is stated. In addition, tests prove that this tough, woven glass fabric possesses the highest efficiency in the prevention of the passage of foreign matter, it is said.

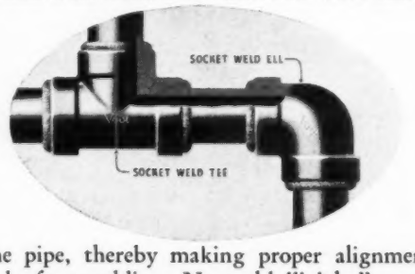
Glastex is ideally suited to the well-known Protectomotor Radial Fin Construction, its makers say. This construction, consisting of a frame of wire radial fins over which the filtering medium is fitted, provides an extremely large area of filtering surface in proportion to the overall size of the filter. For instance, a tiny Protectomotor filter insert only five in. high and five in. in diameter has an active filtering area of 360 sq. inches. This, of course, means longer filter life, low resistance to air flow, and consequent high filter efficiency.



Model CPHL (swing bolt) for liquids

Vogt Drop-forged Steel Socket Weld Fittings

THE Henry Vogt Machine Company, Louisville, Kentucky, has added drop-forged steel socket weld fittings to their well-known line of drop-forged steel valves and fittings. These weld fittings are provided with socket ends to



receive the pipe, thereby making proper alignment certain before and after welding. No weld "icicles" can clog the pipe or fitting because of the socket construction. Due to the similarity of materials in the fittings and the pipe, it is easy to obtain sound welds. Whether standard, extra strong, or double extra strong pipe is used, a smooth passage is assured through pipe and fittings since the fitting bores match the inside diameter of the pipe, the manufacturers state.

Vogt drop-forged steel socket weld fittings are available from stock in sizes from ¼ in. to 6 inch.

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"CLEVELANDS" are driving this story home, out on the line, every day. Proof, on your **own** work is yours for the asking. Write or wire **today.**

Hope that we will have the pleasure of seeing you at our exhibit space in Section 1020 at the World Oil Exposition at Houston, Texas, October 11th-16th.

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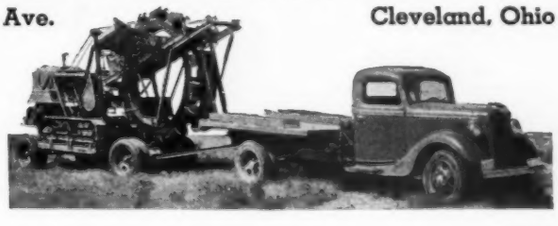


Emsco Rotaries

THE Emsco Type J-20½ and Type JA-20½ fully-enclosed rotary machines have been developed by the Emsco Derrick and Equipment Company, Los Angeles, California, to meet present and future drilling conditions that call for faster table speeds with an ample factor of safety. turers state. To facilitate easier handling, they are much lighter in weight and more compact than the larger tables, yet built unusually strong to meet successfully the severest drilling conditions. Lifting hooks are provided on the table end of the base and can be folded back when the tables are not in use.

The ring guard is an added safety feature. Ribs and corrugations are provided in its design to prevent slipping when the members of the crew find it necessary to step on the table. It also serves to protect the crew from mud that may fly from the table, and presents a flat surface upon which slips may be rested.

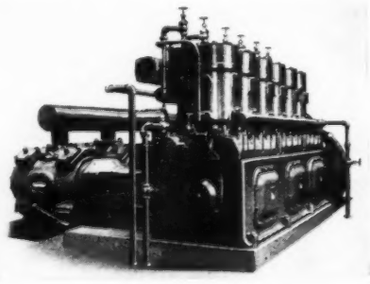
The table proper is totally enclosed. A special grease-packed seal and the improved construction of the pinion bearing assembly prevent mud, water or other foreign substances from entering the table. The lower table bearing, pinion-shaft bearing, and the pinion-shaft lock are lubricated from a convenient central point by the Alemite system. The king gear, pinion and main table bearing are lubricated by splash feed.

An important new feature incorporated in the Type J-20½ and Type JA-20½ rotary machines is the preloaded main bearing that prevents hammering of the races when the tables are running under light loads or being subjected to bouncing, prevalent in drilling certain formations. In this bearing Emsco employs a tapered roller made of alloy, heat-treated, hardened, and ground steel.

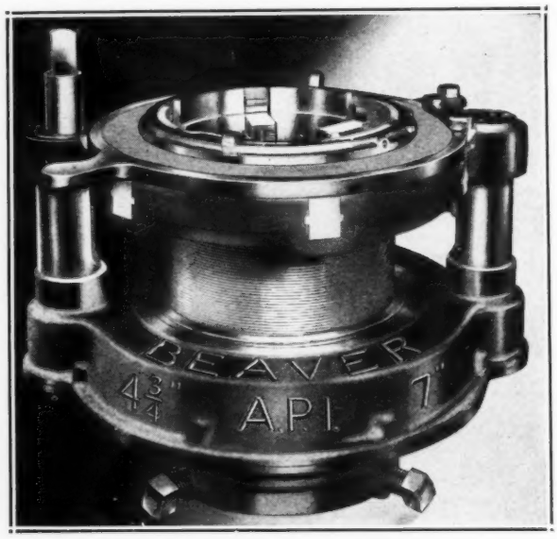
The J-20½ and JA-20½ rotary are standard A.P.I. distance from the center line of the pinion shaft sprocket. There is exactly the same width in the base as the Emsco Type H-27½ table and of the other standard tables on the market, which allows a larger table to be removed from a drilling well and the smaller Type J-20½ or Type JA-20½ tables inserted in the same cradle. Due to the various types of prime movers with varying speeds, the Type J-20½ has been designed with a ratio of 2.95 to 1 for high rotative speeds, and the Type JA-20½ with a ratio of 3.73 to 1 for normal rotative speeds.

Four-Cycle Angle-Type Gas Engine Compressors

TO MEET the demand for a medium size, self-powered, simple, and compact air and gas compressor



unit applicable to the special processing needs of refineries and natural gasoline plants, as well as for gas transporta-



For A.P.I. Casing 4¾ to 7"

The new Beaver No. 407 is a "special" oil field tool. It cuts full-length API threads (in one operation) on 4¾, 5¾, 6⅝ and 7-inch O.D. Casing, 10 thread, ⅜-inch taper, with one set of dies, which are always in the tool.

Dies, fully-adjustable for cutting oversize or undersize threads of standard length, are of solid alloy Vanadium steel. Dies are designed with splines which ride in grooves in the diehead and prevents chipping of dies and excessive wear.

Gear case fully-enclosed. No chips or dirt or sand or grit can plug up these gears.

The driving pinion is supported on both sides of the operating gear. The lower end of the pinion rides in a bronze bushing.

Buy it through your supply house

BEAVER PIPE TOOLS

The Quality Line — Since 1900

937 PETROL AVE. WARREN, OHIO

tion lines, gas or air-lift pumping, refrigeration and general compressor services, a modern line of 4-cycle angle-type gas engine compressors has been developed by Worthington Pump and Machinery Corporation, Harrison, New Jersey. Combining ruggedness and portability, these Type LCE units occupy little space and, although designed for permanent heavy-duty work, are adaptable for locations that may not be permanent, the makers state.

They are built with one to four compressor cylinders, corresponding to 75 hp. to 300 hp.; all compressor cylinders are horizontal and at right angles to the power cylinders. Each compressor cylinder has two corresponding power cylinders and the compressor element can be arranged to deliver any combination of volume and pressure within the limits of the engine rating. With this flexibility, it is possible to meet service conditions for any situation, it it said.

The compressor cylinders are of the standard Worthington design and are fitted throughout with light-weight feather valves. Other features of the compressor include large water jackets and close clearances, all of which, it is said, combine to give high volumetric efficiencies.

The engine is a vertical, 4-cycle type, with power cylinders, valves, and working parts small in comparison with the slower speed horizontal type of similar horsepower. Extremely large water jackets with clean-out plates have been provided.

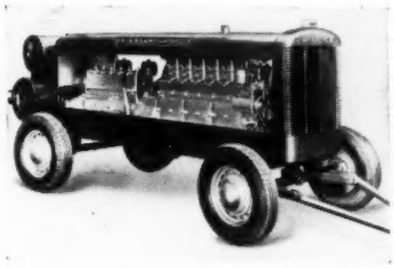
Of particular importance is the fact that, regardless of engine-compressor size, most parts are interchangeable. This feature eliminates the necessity for carrying a large stock of spares on hand. For example, the engine and compressor connecting rods are identical and interchangeable.

Force-feed lubrication is used throughout, and a deep oil sump is provided in the base of the engine. A separate force lubricator is provided for the power and compressor cylinders. All running gear is totally enclosed, making the unit entirely dirt-proof and rust-proof.

As these units are shipped in one piece, they can be installed easily, quickly, and at little expense. It is necessary only to skid them over the bolts, level, and grout them.

New Diesel-Powered Air Compressor

FAIRBANKS, Morse and Company has announced a new self-contained, Diesel-powered, 210-c.f.m. air compressor, available with several types of portable and semi-portable mountings, for a wide range of service applications. This new compressor combines the economy and dependability of the F-M Model 36-A Diesel with the superior design features of a proved air compressor, making available a compact, light-weight unit that offers maximum efficiency and absolute reliability under all working conditions, according to the makers.



Through the proper application of modern principles of engineering design, the compressor unit has been kept light in weight and small in size, contributing to its portability. Ample bearing surfaces and proper lubrication make possible a long trouble-free life. The water cooling system assures thorough and uniform cooling in any climate and under any condition. Low upkeep expense results from the employment of refinements

DEPENDABILITY

. . another reason why **COOKTITE SEALING RINGS** *predominate*

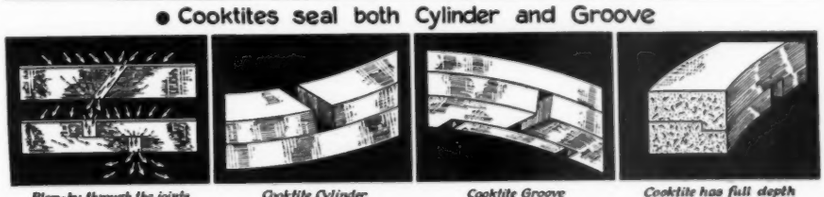
PISTON RING CONSTRUCTION

CHECK THESE FEATURES	COOKTITES	YOUR PRESENT RINGS
Engineered to eliminate "blow-by" in new or worn cylinders	BOTH	
Two-piece sealing ring—or plain ring with improvised sealing joint	TWO-PIECE	
Frail sealing elements to crumble and score cylinder	NONE	
Does pressure loading strain the sealing joint	NO	
Material specially developed for sealing ring requirements	YES	
Full depth radial strength	YES	
Single ring groove landing	YES	
Dual ring cylinder seal	YES	
Time tested in 2-cycle and 4-cycle engines	YES	

√ CHECK this chart

The increased efficiency and reduced maintenance cost that follow the application of COOKTITE Sealing Rings is sufficient reason for the predominance of COOKTITES in internal combustion engines. Yet, important as these operating economies are, it is the **ability of COOKTITES to stand the gaff** that is causing operators to install them when ring replacements are necessary. The COOKTITE Patented Construction does it. COOKTITE dependability is easy to prove . . . Next time you need rings **ORDER "COOKTITES."**

● Cooktites seal both Cylinder and Groove



Blow-by through the joints in ordinary rings — *Cooktite Cylinder Seal* — *Cooktite Groove Seal* — *Cooktite has full depth radial strength*

C. LEE COOK MANUFACTURING CO.

INCORPORATED

New York Cleveland Los Angeles Baltimore **LOUISVILLE, KY.** Chicago Tulsa New Orleans San Francisco

of proved automotive engine design, it is stated.

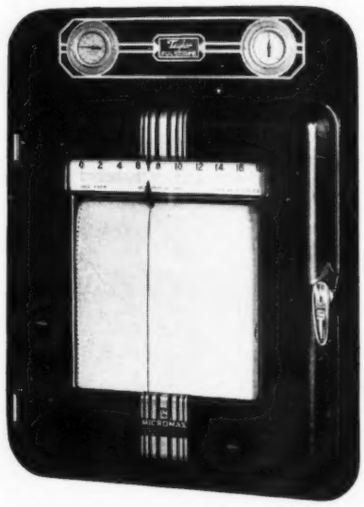
The compressor is designed to operate at full engine speed, permitting direct-connection to the engine without reduction gears or belts and without sacrificing engine horsepower through reducing the rated speed.

The F-M Model 36-A, 4-cycle, 6-cylinder, medium-high speed Diesel engine offers true Diesel economy with necessary flexibility. Its compact, clean-cut appearance is outward indication of inbuilt sturdiness to withstand hard usage. Reliability results from simplicity of design with few moving parts, absence of delicate mechanisms and the use of simple adjustments where any are required. Durability is obtained by the generous proportioning of parts in stress and use of only highest grade materials. The engine is designed to permit easy inspection and servicing.

The new Fairbanks-Morse Diesel-powered air compressor is available with several types of mounting: wooden skid, steel wheel, solid or pneumatic rubber-tired wheel, four- or two-wheeled trailer, and motor or railway-truck. Specifications will be found in Bulletin 3645-A1, available upon request to Fairbanks, Morse & Company, 900 S. Wabash Avenue, Chicago.

Taylor Fulscope Micromax Controller

FOR those process control problems where smooth, proportional valve action is imperative and the potentiometer principle of temperature measurement is preferred, the Taylor In-



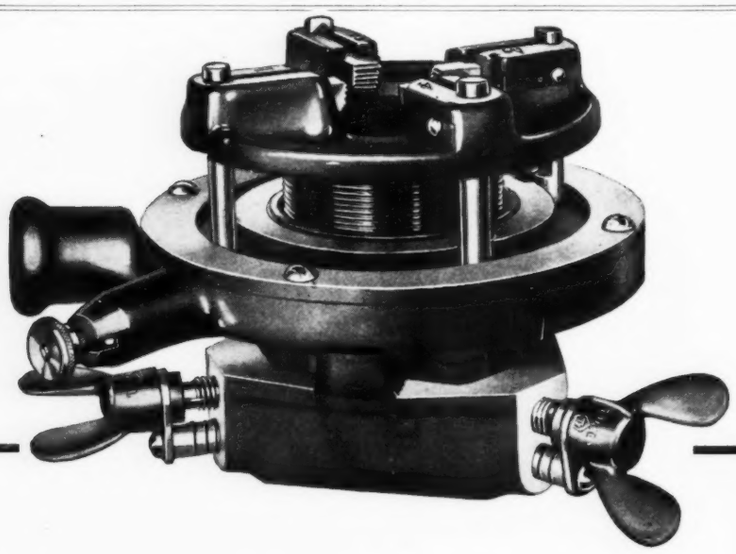
strument Companies, Rochester, New York, now offer the Fulscope Micromax Air-operated Potentiometer Controller. It utilizes the same completely adjustable, air-operated control mechanism that is used in the thousands of Fulscope temperature, pressure, rate of flow, and liquid level controllers now in service, the manufacturers state.

The temperature measuring system is the well-known Micromax recording and indicating potentiometer, in which all functions affecting accuracy of temperature measurement are fully automatic—automatic reference-junction compensation; automatic, positive balancing of the potentiometer circuit; and automatic current standardization.

The principal parts of both mechanisms are interchangeable with the many Fulscope and Micromax instruments now in service. This permits small stocks of replacement parts, lower maintenance costs, and better service, it is stated.

The Fulscope Control Unit operates in conjunction with the Taylor Motosteel Diaphragm Valve. Where precision valve action, or both precision valve action and compensation for changes in load, may be necessary to prevent deviation from the control point, the Fulscope control mechanism can be supplemented with the Taylor Valv-Precisor or Dubl-Response Control Unit, respectively. Thus, control equipment that most economically solves the individual control problem may be selected.

Write for Taylor Catalog 101R.



IT CAN STAND THE GAFF

The "TOLEDO" No. 1BR 1″ to 2″ Ratchet Threader is especially adapted to Oil Field use. No bushings. A separate set of dies for each size—assuring utmost accuracy. Strong and sturdy—good for long hard service.

Three broad-faced chuck jaws with size-marked guide bars and heavy wing-head set screws make for easy accurate centering.

The leading 1″ to 2″ Threader. See your dealer or write us today for complete details.

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Specify a "Toledo"

Left to right—H. T. Swortwood, president, MidCo Bailer Company; W. A. Larson, vice-president in charge of trailer service; and "Jack" Jackson, shop superintendent, MidCo Tool and Supply Company.

Trailer Bailer Service

WHAT officials of the MidCo Bailer Company, Oklahoma City, think to be the first trailer service of its kind is now in operation by that company, designed to provide an efficient cleanout bailer service to operators throughout the Mid-Continent and Gulf Coast fields. In the past few months this trailer has visited fields in Kansas, Texas, Oklahoma, and New Mexico. One of the advantages of the trailer, officials of the service company say, is to make available to operators a clean-out bailer service that can be had on short notice.

W. A. Larson, operator in charge of the trailer service, has been connected with this phase of the oil industry in many other parts of the world before coming to Oklahoma. As field service man for the MidCo Bailer Company, he plans to be in the field at all times and available for call upon request through the main office of MidCo in Oklahoma City.

The MidCo Company formerly was the Ideal Bailer Company.

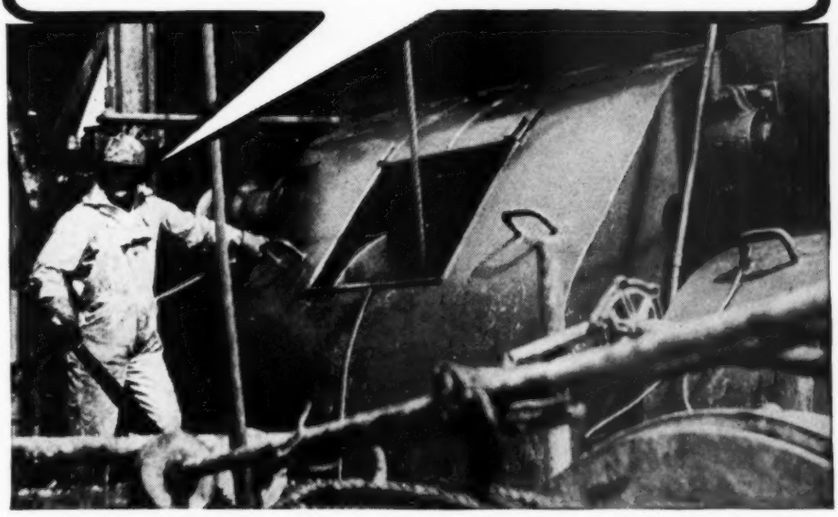
MacClatchie Airflote Slush Pump Valve

AN improved type of slush pump valve has been developed and patented by the MacClatchie Manufacturing Company, Compton, California, and after a number of months of field testing, it is now ready for general distribution, it is announced. This new valve, known as the Airflote, has an air chamber constructed in the body of the valve itself, and in this steel chamber lies the secret of the greatly improved performance. The arched construction not only adds greater strength and rigidity to the body of the valve, but also greatly decreases the weight of the valve and increases the displacement. In air the valve is approximately 20 percent lighter than other types of the same corresponding size, and when submerged in fluid, the difference in effective weight becomes even greater because of the larger displacement and greater buoyance of the valve, the manufacturers state.

The reduced weight improves the efficiency and life of the valve by reducing destructive hammering, and increasing the sensitivity of the valve to slight changes in the fluid movement. Much quicker seating and less fluid slippage at each reversal of the pump stroke are important results of this increased sensitivity.

(Continued on Page 142)

HERE'S A LINING THAT CAN STAND THE GAFF!



TOM SINGLER operating one of the largest and best drilling rigs in the Corpus Christi oil fields, owned by W. A. Richardson Petroleum & Drilling Corp., and equipped with J-M Giant Rotary Lining, Style 410. Both owner and driller are sold on the superior, longer service of this rugged brake lining.

Here's why J-M Lining, Style 410 is the choice on so many Drilling Rigs:

AN EVEN FEED-OFF
. . . assuring better controlled drilling.

LESS SMOKING AND DUSTING
. . . working conditions greatly improved.

SCORING TENDENCY REDUCED
. . . life of brake rim is lengthened.

QUIETER BRAKES
. . . less nerve strain on drilling crews.

Johns-Manville GIANT ROTARY LINING Style 410

JM

WRITE NOW—for full details on our complete line of friction materials. Address Johns-Manville, 22 East 40th Street, New York City.

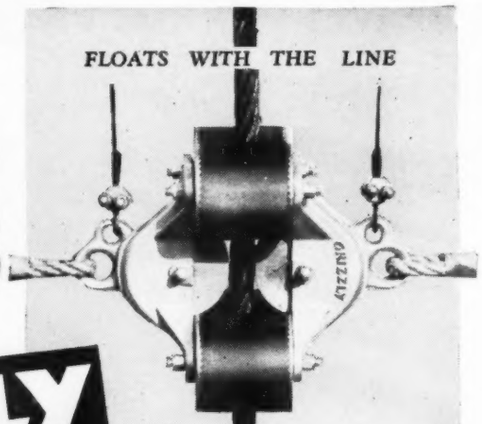
(Continued from Page 141)

In addition, the new Airflote Valve has an outer edge that is considerably thicker than heretofore, and is designed to withstand the high impact strains and terrific cutting action of the high-pressure fluids in today's deep-well pumps. Another new feature is the large diameter thread by which the various parts are held together. This thread has a shoulder like a tool joint. It is positively leak proof, will not jar loose in service, and yet can be readily unscrewed when desired to change rubbers, it is stated. Many of the highly-popular MacClatchie features of past

years have been retained, too. For instance, this valve has reversible rubber inserts that provide double life and double efficiency, and it also has the large streamline striking surface on the valve seat that materially lengthens the life of the entire valve assembly by decreasing the impact stress per unit area and by maintaining these parts in proper alignment throughout the life of the valve.

The new MacClatchie Airflote Valve is an addition to the MacClatchie line of slush pump valves. The popular streamlined valve will continue to be manufactured. The Airflote is made for use where the utmost service is desired.

CUT WIRE LINE COSTS WITH THE GRIZZLY "NO-WIP" LINE SAVER



By eliminating the exhorbitant expense and hazards resulting from excessive wire line wear, Grizzly No-Wip Line Saver positively cuts wire line costs. Without straightening or injuring the line, it takes out the whip; and at the same time forces the line to track perfectly, prevents uneven piling on drum, and simplifies spooling.

Grizzly No-Wip Line Saver is not a rigidly controlled guide and functions perfectly at any angle, regardless how installed. Substantially constructed of the finest materials, it is strong, durable and light in weight; insuring dependable service and long wear. Write for Bulletin No. 10-OF.

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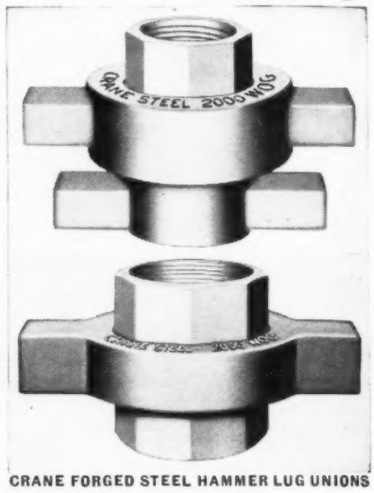
600-650 South Clarence Street • Los Angeles, California, U. S. A.
Complete Stocks Maintained In Our Warehouses At: 2311 West St., Houston, Texas. 1008 S.E. 29th St., Oklahoma City, Oklahoma. Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York City.
Distributed by Leading Supply Companies

Crane Forged-Steel Hammer Lug Unions

AN addition to the products manufactured by Crane Co., Chicago, Illinois, is a new line of hammer lug unions. Actually, these unions comprise two distinct lines: (1) forged-steel screwed unions with one set of lugs, and (2) forged-steel screwed unions with two sets of lugs. Both of these unions have been designed for use in piping systems requiring frequent, or quick, dismantling, either to save time on the job, or for emergency purposes. In either case, a blow with a hammer upon the lug will immediately break the joint without using a wrench.

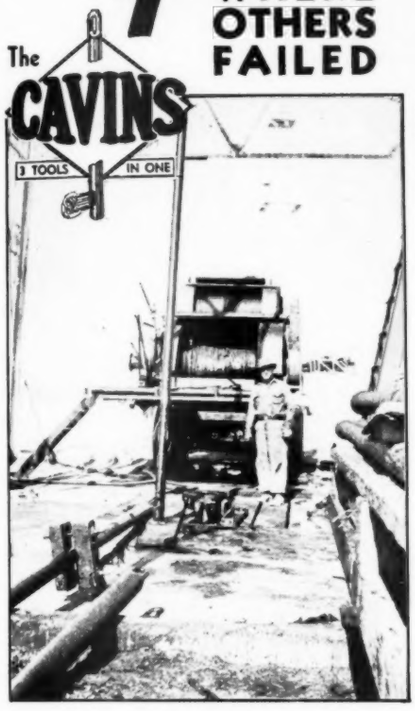


CRANE FORGED STEEL HAMMER LUG UNIONS

The oil industry has found that these unions save much time and labor in field work around the boiler, because frequently, a complete unit has to be dismantled in a hurry and moved to a new location, the makers state.

The single lug union is made with forged steel tailpieces and thread pieces in sizes 2 in., 2½ in., 3 in., and 4 in. (these parts are of cast steel on the 4-in. size) and have lugs on the union ring. The double lug union is all forged steel, having lugs on both the union ring and the thread-piece. It is made in sizes ⅜ in., ½ in., and ¾ inch.

CAVINS Makes Good WHERE OTHERS FAILED



The snapshot above tells a forceful story . . . the folly of using old-fashioned and inefficient tools for cleanout work. In the foreground are two types of bailers that failed on this cleanout job and had to be abandoned.

The Cavins Automatic Hydraulic Suction Bailer, standing in the derrick, was third on the job. It got right down to business and had this well cleaned out in jig time. The smiling operator indicates his satisfaction . . . it's a pleasure to run the Cavins.

For complete details of the Cavins, send for Bulletin No. 36.

THE CAVINS COMPANY

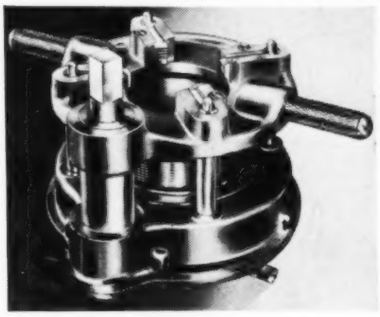
2853-73 Cherry Ave., Long Beach, California

BRANCHES:

CALIFORNIA: Bakersfield, Taft, Ventura
TEXAS: Houston, Kilgore, Odessa, Big Spring, Monahans, Pampa
OKLAHOMA: Ada, Oklahoma City, Perry
NEW MEXICO: Lovington TRINIDAD, B.W.I.

Beaver Pipe Tools, Inc., No. 48-R Pipe Threader

FOR those who prefer the semi-adjustable taper-post type of pipe threader, using a separate set of dies for each size, Beaver Pipe Tools, Inc., Warren, Ohio, has placed on the market the No. 48-R, which threads 2½-



in., 3-in., 3½-in., and 4-in. pipe. Five important mechanical improvements are embodied in its design:

1. An extra wide die—with a wide throat to center and hold the tool on the pipe. This eliminates the annoyance of having the tool drop out of threading position when a power drive is applied.
2. The gears are fully-enclosed so that chips and dirt cannot get in them.
3. The driving pinion is "straddle-mounted"—with a bearing both above and below the gear teeth on the pinion.
4. The dies are held in position by a spring-backed ball, fully-enclosed so that dirt cannot get back of it.
5. The proper position for setting dies to cut a "standard" thread is marked by a shoulder on the tapered post. This makes accurate setting possible, even under poor lighting conditions.

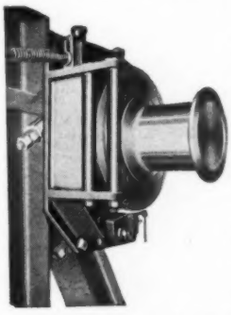
G-E Motors for Deep Water-Well Pumping

BECAUSE of the growing demand for deep water-well pumping equipment, the General Electric Company, Schenectady, New York, has developed a new line of vertical hollow-shaft motors for pumping service. Outstanding among the many improvements that this line of motors embodies are a simplified oiling system for the top (thrust) bearing, a ball-type guide bearing, and more attractive appearance. The motors also afford high full-load speed, adequate starting torque, high efficiency, double-end ventilation, and full mechanical protection.

In the new G-E motors, the oil housing is situated in the top end-shield and is divided into two parts by a cylindrical wall that supports the

(Continued on Page 145)

IT takes "follow thru" to give a long smooth stroke packed with power—and that's exactly what you get in the MacClatchie Gearomatic Cathead! Geared 2 to 1, this cathead has *double* the power at *half* the line shaft speed, giving tremendous force to smoothly break the largest, most stubborn tool joints without jerks and *without impact strains on rig equipment.*



And remember—this ruggedly built cathead has no clutches to jam or get out of adjustment. A positive kick-out device allows one revolution—and *one only*—per pull, positively eliminating fouled lines and assuring definite safety for crew and equipment.

Get in touch with your nearest MacClatchie representative today. He will gladly explain the time and money-saving features of this modern cathead.

MACCLATCHIE
MANUFACTURING CO.
Compton, Calif. Houston, Texas

Export:
Geo. R. Woods, 17 Battery Pl., New York

Tough!

The men who make Youngstown oil country goods know that a single "twist-off" can kill the profit on an entire drilling job. They also know that a thread that doesn't make up properly can kill valuable time and leave a weak string.

These men never saw an easy-going inspector. They've been born and raised on standards of precision that most people would call impossible, and that is why their pipe works with you on the job and not against you -- -- why it is easier to use, always the same, always a help toward a fast and profitable job.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - YOUNGSTOWN, OHIO

OIL COUNTRY TRADE MARK YOUNGSTOWN TUBULAR GOODS

Youngstown's pipe is distributed by --

The Continental Supply Company, Dallas, Texas
Continental Emsco Co., Inc. 30 Rockefeller Plaza, New York City
Republic Supply Co. of California, Los Angeles

2-5

YOUNGSTOWN

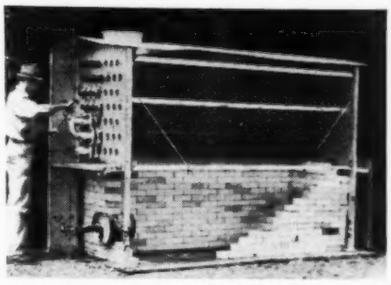
(Continued from Page 143)

outer race of the thrust bearing. An inner compartment, containing the thrust bearing, is connected to the outer by a small metering hole protected by an oil screen. The oil gauge is so arranged that when full, the oil level is even with the top of the balls in the thrust bearing.

When the motor is at rest, oil flows into the inner bearing cavity until the oil level is equal to the height of the oil in the outer compartment or reservoir, thus flooding the bearing and protecting it against rusting in idle periods. As soon as the motor starts to rotate, the pumping action of the ball bearings begin to clear the inner housing of excess oil and, by the time full speed is reached, the rate of lubrication is regulated by the rate of oil flow through the metering hole and is independent of the motor's operating speed.

Tubular Treating Heater

A NEW tubular heater for treating oil field emulsions has been placed on the market by Black, Sivalls and Bryson, Inc., Oklahoma City, Oklahoma. The equipment is constructed like an up-to-the-minute refinery pipe still. Runs of common 2-in. pipe are folded back and forth into compact



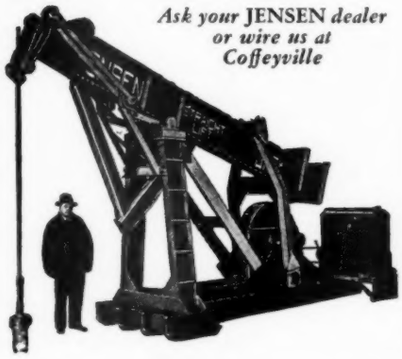
heat-absorbing bundles. Novel two-bolt flexible-joint "U" bends return the runs. These return bends are fashioned as follows: A flexible "ground joint union" leak-tight connection is made directly between the pipe end and the metallic seat pressed into the return bend. The pipes are held home by yokes having two bolts. The return bends can swivel to make up for considerable variation in lengths of the pipes (plus or minus ¼ in.). The pipe ends are threaded long enough to clear the yokes. It is only necessary to "touch up" the last thread a bit with a file and the joint will be leak-tight under a very considerable pressure.

A high-pressure gas burner fires beneath the heating tubes. A special long bulb thermostat in the last pass controls the heat. The common brick heat setting can be laid up dry. A sheet-metal weather housing, with stack, bolts over all.

You'll Have Less Trouble With That Well . .

. . . if you pump it with a JENSEN Straight-Lift JACK. Easy to install. Requires very little power. Does not get out of order itself, and does not whip and lash the sucker rods until the stuffing box leaks and the rods break. Has an absolutely straight lift. Most satisfactory unit on the market. Made by men who have designed and perfected pumping equipment exclusively for 19 years, assisted by successful producers. Investigate!

Ask your JENSEN *dealer or wire us at Coffeyville*



JENSEN

BROTHERS MANUFACTURING CO.

. . . Coffeyville, Kansas

DEEP CORING

with Quick Accurate Results is assured with the

HUNT

Retractable Barrel

Nobody knows, better than the Contractor, how coring failures take the profit out of a deep hole . . . and nobody knows, better than the Contractor, the many advantages of the HUNT WIRE LINE BARREL, especially where great depths are drilled. Hard and Soft formation heads interchangeable.

Ask for Descriptive Literature.

Rental Service in U.S. For Sale Foreign.

HUNT TOOL COMPANY — HOUSTON, TEX. — Patented AUTHORIZED APPLEMAN BIT SERVICE CO. — HUNT WIRE LINE CORE BARRELS

BIT SERVICE SHOPS:
Houston, Joinerville, Talco, Corpus Christi, Bay City, Alvin, Texas . . . Rodessa, Jennings, Houma, Louisiana.

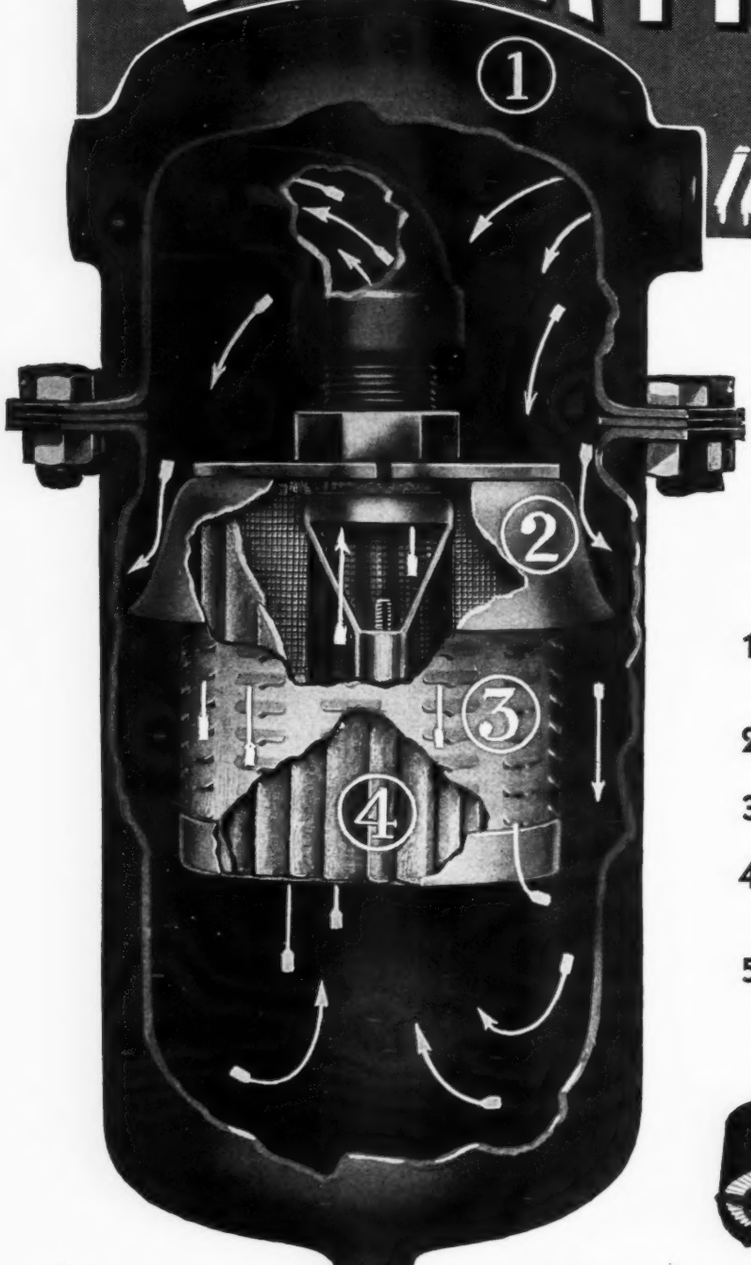
STRAIGHT TALK .... *about* CROOKED HOLES

Write for literature

SPERRY-SUN WELL SURVEYING CO.

1608 Walnut Street, Philadelphia, Pa.
425 Petroleum Building, Tulsa, Okla.
3118 Blodgett Avenue, Houston, Texas
549 East Bixby Road (3800 Block—Atlantic Ave.) Long Beach, Calif.
Bank of Lafayette Bldg., Lafayette, La.
c/o Elks Club, 17th and I Streets, Bakersfield, Calif.

BETTER PROTECTION FOR AIR LINES IN COLD WEATHER



Cold weather soon. Then you'll need better protection for your compressed air lines. Use the better Protectomotor air filters to remove water caused by condensation in cold pipes; also oil, rust, dirt, pipe scale and all other impurities that injure air using tools and spoil delicate processes. *More than 500,000 Protectomotors have been manufactured and sold for engine and air line protection.*

PROTECTOMOTOR FEATURES:

1. Heavy gauge seamless pressed steel flanged container with threaded intake connections in standard sizes. Horizontal and vertical models (former illus.)
2. Scientifically shaped baffle driving most water, oil, etc., to sides of container. Liquid drains to bottom.
3. Louvred aluminum filter housing surrounding filter insert. Strong rustless, ever wearing.
4. Positive filter insert of Feltex Filtering Medium in the famous Radial Fin Construction, providing large area for filtering. Easily removed. Exclusive.
5. Drain cock. Filter easily cleaned by shutting off entering air, when air pressure in line backs up and blows foreign matter off filtering surface; cock drains liquid.

Protectomotors for compressor and internal combustion engine intake. Model DS (right) *silences* as well as filters.

MODEL "CPH"

ALSO FILTERS FOR VENTILATION AND DUST RECOVERY
WRITE DEPT. 2 FOR CATALOG

PROTECTOMOTOR
REG. U.S. PAT. OFF.
99 9/10 Per Cent EFFICIENT
AIR FILTERS

STAYNEW FILTER CORP.
ROCHESTER, NEW YORK
"AIR FILTER HEADQUARTERS"

PROTECTOMOTOR

Recommends New Building For International Petroleum Exposition

A new International Petroleum Exposition building is being recommended to the directors by Wm. B. Way, general manager of the Exposition, to be added to the five huge buildings already on the grounds.

The Tulsa oil show, to be held May 14 to 21, reports the sale of exhibit space this far ahead of the show to be the largest in the history of the Exposition.

"There is more available exhibit space by 40 percent than ever before with the additional outside space, and 105,231 sq. ft. of the total, 193,130 already has been contracted," said Way.

"Approximately 42 percent of the 1936 exhibitors are desiring increased space for the 1938 show, and I am recommending this new building so that every legitimate oil industry exhibitor will receive adequate space and will be provided with all necessary exhibit facilities," he said.

Work is underway on improvements to the International Petroleum Exposition buildings and grounds. Above is shown nearing completion the ground floor and the foundation of the modernistic air-cooled cafeteria building being erected at the east side of the grounds

The five buildings already on the grounds include the Oklahoma, Texas, California, Scientific, Refiners and Marketers buildings. They have a total of 476 booths.

President W. G. Skelly has predicted an increase of 35 percent in attendance for the May show and the Exposition housing bureau, under the direction of Earl Sneed, gives assurance that every visitor at the Exposition will be provided with adequate housing facilities. This committee is now organized and will take care of reservations.

"The International Petroleum Exposition Safety committee, which is to have charge of the safety-day activities during the show, has been appointed and is working out plans for the May show. The general committee includes: J. D. McCamey, the Carter Oil Company, chairman; H. W. Boggess, Sinclair Prairie Oil Company; F. K. Dalrymple, Tide Water Associated Oil Company; Kraus Erhart, The Texas Company; R. S. Huffman, Oklahoma Natural Gas Company; T. A. Lyttle, Cities Service Gas Company; H. T. Jarkee, Phillips Petroleum Company; E. D. Murphy, Mid-Continent Petroleum Corporation; J. H. Savage, Mid-Continent Petroleum Corporation; D. J. Wallace, Sinclair Prairie Oil Company; J. C. Young, Tide Water Associated Oil Company; and H. H. Myers, of the Sinclair Prairie Oil Company.

Morgan in Illinois For BJ

The Oil Tool Division of Byron Jackson Company announces the establishment of a sales and service office at 425 South Fair Street, Olney, Illinois, with O. W. Morgan, Jr., in charge. Morgan has been connected with Byron Jackson Company for several years in a similar capacity in California, and his knowledge of BJ drilling and production tools will enable him to render prompt and satisfactory service to Illinois operators.

Lufkin Foundry Moves Tulsa Office

The Tulsa office of Lufkin Foundry and Machine Company, Lufkin, Texas, has been moved to 719 Thompson Building. D. A. Reid is in charge.

W. J. Morris and Mrs. Marian Lane Newsome Married

W. J. Morris and Mrs. Marian Lane Newsome were married on Saturday, September 18, 1937, at the home of the bride's daughter, Mrs. David Oberweiser, 169 East 78th Street, New York City. After a wedding trip to White Sulphur Springs, West Virginia, Mr. and Mrs. Morris will be at home in Dallas. Morris is president of The Continental Supply Company, Dallas.

W. J. MORRIS

Mrs. Morris is the daughter of Mr. and Mrs. A. V. Lane of Dallas. Mr. Lane is a vice-president of the First National Bank in Dallas.

Percy Jones Entertains With Dinner and Movie on Sucker Rods

P. C. Jones, president of S. M. Jones Company, recently provided some 130 prominent oil men, including engineers, superintendents, etc., in the Tulsa area with an excellent dinner at the Tulsa Club and the premier showing of a moving picture on the care of sucker rods.

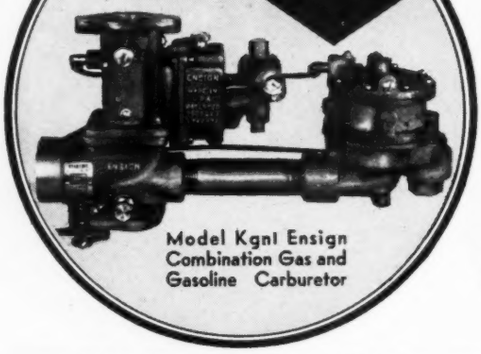
H. K. Browning, sales manager of the S. M. Jones Company, acted as toastmaster, and after those present had listened to the radio speech of Supreme Court Justice Hugo Black, introduced Otis Beeman, of the advertising agency of Aubrey, Moore and Wallace, who wrote the script for the movie.

P. C. Jones made a talk in which he informed those present that the picture was a year and a half in the making and was prepared solely for the purpose of educating field men in the proper methods of handling sucker rods to assure better pumping conditions.

The picture showed first how the rods are made and tested, how handled into and off freight cars, unloading at the well, running in, checking in the wells, etc. In each step both the right and wrong methods of handling were stressed. To prevent the picture from becoming a drab recital of facts a mythical character, "Rodney", was introduced. A hitchhiker on his way to California, "Rodney" was picked up by a crew on the way to the field, taken along, and given a job. Knowing nothing of oil-field work "Rodney" naturally did everything the wrong way, and the foreman's instruction on how it should be done brought out in an interesting manner facts concerning the proper handling of sucker rods.

Those present were in agreement that pictures of this kind should be made available to superintendents, engineers, and field men throughout the industry as an effective means of preventing many of the prevalent abuses to sucker rods.

DUAL FUEL Economy



Model Kgnl Ensign Combination Gas and Gasoline Carburetor

Precision built and service proved, the product of 26 years of highly specialized experience in the development and manufacture of eminently successful carbureting and fuel regulating equipment for industrial power units.

The Ensign Combination Gas and Gasoline Carburetor assures dual fuel economy by using either gas or gasoline for fuel, changing instantly from one fuel to the other while operating. Power users benefit through favorable price fluctuations of either fuel, in addition to the fine precision performance of the carburetor. Write for complete data.

ENSIGN CARBURETOR CO., Ltd.
Huntington Park ◆ California
Branches: Chicago, Illinois; Dallas, Texas

No Seams—

—Greater Strength

Hough Working Barrels are *seamless*—for longer life under severe conditions. Made to A.P.I. specifications from highly specialized cold-drawn tubing. All standard sizes — with smooth, bright bore or chromium-plated bore. Oil-field distributors carry Hough products in stock. The Charles N. Hough Mfg. Company, Franklin, Pa.

Hough SEAMLESS STEEL Working Barrels

Trade Personals

W. W. TROUT, of the Lufkin Foundry & Machine Company, Lufkin, Texas, and J. S. HUDNALL, consulting petroleum engineer, Tyler, have been appointed by GOVERNOR ALLRED to the State Board of Registration for Professional Engineers.

●

CLARENCE WHITE, president, Oil Well Manufacturing Corporation, Los Angeles, California, manufacturers of oilfield specialties, is spending two or three weeks visiting the Mid-Continent oil fields.

●

GEORGE MORRIS, president, Bradford Motor Works, Bradford, Pennsylvania, is making a several weeks' business trip through the Mid-Continent.

●

DAVE BEATTY, general sales manager of the American Lubricator Company, Dallas, Texas, has returned to his headquarters following a business trip through California fields.

●

C. V. LALLY, manager of seamless steel pipe sales for the Pittsburgh Steel Company, Pittsburgh, Pennsylvania, is making an extended trip through the Mid-Continent and Gulf Coast fields. He also attended the Oil-World Exposition at Houston, Texas.

●

ROSS LANGILL, chief engineer, The Prescott Company, Menominee, Michigan, recently visited Tulsa, Houston, and other Mid-Continent and Gulf Coast points.

●

ALFRED KAUFFMANN, president, Link-Belt Company, announces that at the quarterly meeting of the board of directors, held in Chicago, WILLIAM C. CARTER and EDWARD J. BURNELL were elected vice-presidents. Carter has been in charge of company production, with headquarters in Chicago. Burnell has been general manager of the Pershing Road Chicago plant.

●

MILLER SHEFFIELD, Cushing, Oklahoma, representative of the Axelson Manufacturing Company, passed away recently as a result of an accidental fall at Perry, Oklahoma. For many years he has been well and favorably known in the Mid-Continent oil industry.

●

W. R. PERSONS has been appointed manager of the Pittsburgh welding sales-engineering office of The Lincoln Electric Company, manufacturer of arc-welding equipment, Cleveland, Ohio. Persons has been working in the Pittsburgh office since the fall of 1934 and has wide acquaintance with industrial firms in the district. He will be assisted by J. H. PAINTER, M. S. SCHONVIZNER, R. H. SCHUSTER, and H. E. WHITE.

●

A. T. DONLEY, formerly with Allegheny Steel Company, has joined the sales organization of A. M. Byers Company, Pittsburgh, Pennsylvania, according to an announcement by M. J. CZARNIECKI, Byers' vice-president of sales. Donley will be in charge of steel tubular sales in the petroleum industry. His headquarters will be 1270 Arcade Building, St. Louis, Missouri.

●

RALPH L. WILSON, formerly metallurgical engineer of the Timken Steel and Tube Division of the Timken Roller Bearing Company, has become associated with the Climax Molybdenum Company in the capacity of metallurgical engineer in

its development field. His headquarters will be in the Canton, Ohio, office of the Climax Molybdenum Company. He will devote much of his time to furthering the development of suitable steels for elevated temperature service in oil refineries and also for boilers.

●

CHARLES VELIE and RAYMOND HEATH have been added to the sales force of the Hancock Valve Division of Manning, Maxwell and Moore, Inc., Bridgeport, Connecticut. Velie will make his headquarters in Chicago and Heath in Dallas. Both will devote their time to the promotion of sales through distributors.

●

E. CORNING FABER has been added to the sales engineering staff of Oliver United Filters, Inc., New York, Chicago, and San Francisco. He formerly was associated with Filtration Engineers, Inc.

●

C. O. FAIRCHILD, director of research, C. J. Tagliabue Manufacturing Company, Brooklyn, New York, spent a few days in Dallas with A. G. KOENIG, manager of the Dallas office, on his way to Houston where he presented a paper "Trends in Pyrometry" at the Oil-World Exposition.

Gustin-Bacon Appoints R. C. Harden Eastern Manager

Ralph C. Harden has been appointed by the Gustin-Bacon Manufacturing Company, Kansas City, Missouri, as general manager of its eastern division. Eastern headquarters will be located in New York City.

Harden's sales and executive experience has been well balanced. With the Johns-Manville Sales Corporation for years, he was successively salesman, insulation and packing sales manager, division manager and regional vice-president with headquarters in Chicago. For the past three years he has served as general department sales manager with the United States Rubber Products, Incorporated, New York.

RALPH C. HARDEN

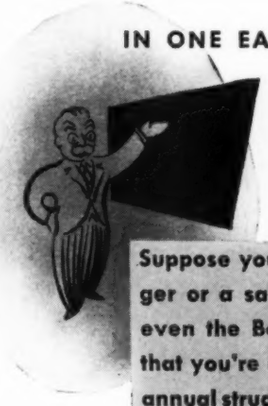
New Sound Movie Features Manufacture and Use of Sucker Rods

Oil Well Supply Company announces completion of its motion picture, "Sucker Rods from Mine to Well," a 16 mm. talkie—showing time, 26 minutes. This picture shows not only the processing of sucker rods from the ore mines to the oil fields, but also the handling of the rods in the field. Many close-ups are used in illustrating recommended practices for the care and handling of rods in the field. The chief causes of rod failure are shown by animated diagrams.

"Sucker Rods from Mine to Well" is now available for showing at safety meetings, engineers' clubs, etc. Requests for use of the film can be made through any "Oilwell" representative.

How to win Sales and influence Quotas . . .

IN ONE EASY LESSON



Suppose you're a salesmanager or a salesman or maybe even the Boss. And suppose that you're in the midst of the annual struggle to decide *what* to give your customers *this* Christmas.

And suppose, just about the time you're ready to go nuts, you happened to think of giving subscriptions to ESQUIRE as gifts. Nine times out of ten* you'd realize the struggle was over and you'd grab your list and dictate a quick memo to the purchasing department.

*Suppose you're the one out of ten who doesn't know instinctively that ESQUIRE Gift subscriptions are the answer to the problem. In that case we'll include a few sales arguments for you to use on yourself.

Being sales-minded you know that the product is its own best argument. Look a copy of ESQUIRE over carefully. A few minutes with the magazine will convince you.

PRICE: . . Reasonable.

SUITABILITY: Universal. It's the "Magazine For Men" but, in case you didn't know, women like it, too.

VALUE: . . ESQUIRE has the impressiveness of bulk, the universal appeal of lavish color, the interest of splendid articles and fiction, the presentations of leading advertisers, authoritative fashions for men, and portfolios of the work of leading contemporary artists.

WILL IT DO THE JOB? . With the arrival of ESQUIRE every month your customer will be reminded of the donor—a welcome Christmas gift split into twelve parts and spread out over a year.

For complete information about Esquire's Gift Plan and Special Rates, write immediately to Christmas Dept. 101, Esquire, 919 North Michigan Avenue, Chicago, Illinois.

Buckeye

Service Ditcher

. . . . JUST RIGHT

MODEL 12

for DITCH 15" to 24" WIDE

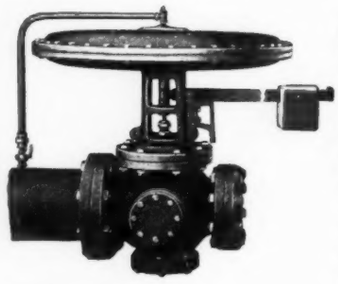
Some ditching looks easy — until you start. Or it may look plenty tough. But whether stony soil, restricted right of way, heavy time penalties in the contract, exactness required, or any of a dozen other difficulties confront you, a Buckeye Model 12 will see the job through on schedule.

It digs trench 15" to 24" wide to 5½' deep, at speeds ranging from 22" to 156" per minute. An additional sprocket gives 28' per minute. No soil short of solid rock can stop it. Complete facts are yours for the asking.

BID THE Buckeye WAY • ask for our operation data before you bid •

THE BUCKEYE TRACTION DITCHER CO.
FINDLAY, OHIO, U. S. A.

Easily Installed • Valve Seats Easily Replaced • Control Sure



CF

Fulton Low-Pressure Regulator

Easy installation, easy replacement of valve seats when needed, and unfailing reduction of comparatively high pressures to suitable pressures for use —even very low pressures if required — are advantages of the Fulton Low-Pressure Regulator. Changes of pressure on the inlet side have no effect on delivered pressure, which is kept constant. When valve seats become worn, they can be replaced without disturbing the body of the regulator. Simple directions are furnished. Descriptive Bulletin No. 1150 will be mailed on request, also catalog of Chaplin-Fulton regulators for all gas-control uses.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Avenue Pittsburgh, Pa.

TRADE LITERATURE

A Highly-Improved Compressor Unit, of the horizontal, gas engine-driven type, is fully described in a very clean-cut and easily interpreted bulletin recently issued by The Cooper-Bessemer Corporation. This new unit, of either single or twin-cylinder design, is identified in the Cooper-Bessemer line of engines and compressors as "Type 12". It embodies, among other features, individual magnetos for each cylinder, placed close to the spark plugs and with ignition cables less than a foot long; a separate governor-valve for each cylinder, situated at the point of injection; and cam-operated, micrometer-adjusted fuel injectors. The single-cylinder unit is rated 125 b.hp., and the twin-cylinder unit 250 b.hp., both at 200 revolutions per minute.

Among the many applications for which the Type 12 is designed, are gasoline extraction from gas, handling still vapors and weathering gases in refineries, refrigerating and air-conditioning, air and gas-lift operations, repressuring of oil sands, and gas booster station work.

A limited number of these bulletins are available. Requests should be addressed to The Cooper-Bessemer Corporation at Mount Vernon, Ohio.

●

A Book of Unusually Instructive Photographs that pictorially tell the story of steel from iron ore mine to finished products has been published by The Youngstown Sheet and Tube Company. Compiled in the style of popular picture-story magazines using action photographs and brief, to-the-point captions, the book contains 115 pages of basic steel information including a total of 135 action photographs taken in the company's mines and mills. The book is entitled "What We Make and How We Make It".

The book is handsomely printed in convenient pocket size and bound in a leatherette cover. Officials, salesmen, engineers, and others interested in the book may obtain copies by writing the Sales Promotion Department of The Youngstown Sheet and Tube Company, Youngstown, Ohio.

●

The Bradford Motor Works, Bradford, Pennsylvania, manufacturers of oil well supplies, have published a sheet in three colors on B-M-W Balls and Seats. The sheet gives detailed information on the B-M-W six leading types: Chromard, Monarch, Bramo, Lumonel, Bi-Metal, and Extrard Bronze. It includes dimensions for the standard sizes as well as for additional sizes, together with prices. Sizes and prices also are given on B-M-W Drops and Seats.

●

The Linde Air Products Company, unit of Union Carbide and Carbon Corporation, announces the publication of a folder, entitled "Steel Hard-Facing Procedure." This useful pamphlet presents detailed instructions for applying the hard-facing material, Haynes Stellite, to steel wearing surfaces. Illustrations, sketches, and a new, simplified step-by-step procedure should enable any welding operator to hard-face steel with good results. Copies are available without charge or obligation from any office of The Linde Air Products Company.

●

The Lone Star Cement Corporation, Dallas and Houston, Texas, manufacturers of "Starcor," "Incor", and "Lone Star" cement, have issued two new booklets. One, "Principles of Oil Well Cementing," shows by diagram and description the various steps in the cementing of an oil well. "Technical Data on Oil Well Cements" contains a series of

charts giving reference data for those whose work includes the cementing of wells.

●

THE PACIFIC PUMP WORKS has issued a new bulletin on their streamlined pumps and fittings, copy of which may be obtained by writing the company at the following address: 5716 Bicket Street, Huntington Park, California.

●

GEO. S. MEPHAM CORPORATION, East St. Louis, Illinois, has issued a booklet on Jelox in which is discussed the use of bentonite as a drilling mud. That portion of the booklet entitled "The Colloidal Behavior of Jelox", and the section covering the use of bentonite in sodium chloride solutions are worthy of particular attention. The graphs give evidence of being the result of a great amount of laboratory work and should prove helpful to engineers who are required to handle various problems. The booklets are being mailed free to interested parties upon request.

●

THE BRIDGEPORT MACHINE COMPANY, Wichita, Kansas, has issued a well-written, handsomely printed and well-illustrated booklet describing its service to the petroleum industry. Illustrations show the company's plant, the various manufacturing departments, typical installations of equipment, officials, etc.

●

A REVISED EDITION of the booklet, "Haynes Stellite Products in the Oil Fields," has been published by Haynes Stellite Company, Unit of Union Carbide and Carbon Corporation. The new edition describes in detail the complete procedure for hard-facing and hard-setting oil well bits with Haystellite. Recent additions to the booklet include a section on Haynes Stellite J-Metal cutting tools, giving the specifications of these tools as well as briefly describing recommended practices for using them, and a new section devoted to the corrosion-resistant Hastelloy alloys. Copies of this booklet can be obtained without cost or obligation upon request to any Haynes Stellite district office or to the general office in Kokomo, Indiana.

Annual Meeting Petroleum Industry Electrical Association to Be Held in Houston

The Petroleum Industry Electrical Association will hold its next annual meeting at the Rice Hotel, Houston, Texas, April 13 to 15, inclusive, it has been announced. Although details of the program have not been formulated at this time a number of papers will be read and entertainment features provided.

The Petroleum Industry Electrical Association, organized in 1927, is composed of approximately 22 oil, gas, and pipe line companies whose representatives meet each year for consideration of matters pertaining to communication and electrical appliances in the petroleum industry. T. J. McMahon, vice-president and superintendent of operations, The Texas Pipe Line Company, Houston, Texas, was the founder of the organization.

Present officers of the association are: P. F. Davis, The Texas Pipe Line Company of Oklahoma, Tulsa, Oklahoma, president; E. M. Smith, United Gas System, Houston, Texas, vice-president; H. E. Browne, Sinclair Refining Company, Pipe Line Department, Independence, Kansas, secretary-treasurer. Directors include: F. P. O'Connor, Stanolind Pipe Line Company, Tulsa, Oklahoma; J. W. Flint, Empire Companies, Bartlesville, Oklahoma; D. W. Sims, Continental Pipe Line Company, Ponca City, Oklahoma; Morris Chambers, Standard Pipe Line Company of Louisiana, Shreveport, Louisiana; and J. F. Collerain, Houston Pipe Line Company, Houston, Texas.

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STARTS
WHERE OTHERS FAIL!

The revolutionary features in the construction of the new self-unloading Shull Sand Pump allows you to get larger loads on every stroke. High vacuum is maintained in the tubing with only an 11-foot stroke on the plunger. This allows 28 feet of load chamber. Solid steel sucker rod instead of the conventional hollow shaft allows you to use maximum size tubing with no danger of sticking in the casing. This is the first trouble-free, self-unloading sand pump on the market.

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C. E. White Joins Waukesha Staff

CECIL E. WHITE

Cecil E. White, formerly sales promoter for the Milwaukee division of the Standard Oil Company, has joined the sales staff of Waukesha Motor Company's Gas Power Division. He will assist Mr. Kilpatrick in the promotion of the new automatic power units, recently announced, as well as the Waukesha automatic deluxe gas power units. White will devote his time to sales promotion as well as sales work in the field.

Neal Higgins Heads International Industrial Sales

The continued expansion of International Harvester's industrial tractor and power unit business has necessitated a realignment in its sales department personnel, it is announced. As a result, Neal Higgins has been placed in charge of all industrial tractor and power unit sales through branches, dealers, and manufacturers, while R. C. Flodin, heretofore in charge of the division, has been assigned new responsibilities. Higgins has been closely identified with the sale of the company's industrial power lines for the past five years.

New Office For the Linde Air Products Company

The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, has signed a contract for the occupancy of a new, fireproof office building at 729 North Pennsylvania Street, Indianapolis, Indiana. The new building, a two-story structure, is to be ready for occupancy on or about November 1, 1937, and will provide space for the Linde district office and a repair and service station for Oxweld oxy-acetylene welding and cutting apparatus.

The company also announces that its Boston district office has moved to 441 Stuart Street, Boston, Massachusetts.

Picnic For Baash-Ross Employees

Climaxing weeks of preparation on the part of the executives delegated to the task, Baash-Ross Tool Company recently held an all-day picnic for employees and their families at the Lakewood Country Club in Long Beach, California. More than 1000 persons were in attendance, and the entire Country Club, including club house facilities, restaurant, card rooms, ball room, an 18-hole golf course, ball diamond, and other recreation grounds were at the disposal of the picnic guests exclusively for the entire day. All sorts of games from golf to egg races were organized, affording an opportunity for everyone to compete for carefully selected prizes. Pony rides, ice cream, candy, and special games were available to the hundreds of children. An excellent dinner was served in the dining rooms to all the guests. Toward the close of the day more than 36 major prizes and many second and third prizes were awarded to the winning contestants by L. F. Baash, president of the Baash-Ross Tool Company, assisted by H. C. Ross, vice-president, and the other executives.

Lane-Wells Company Holds Picnic

More than 500 employees and guests attended the first annual Lane-Wells Company picnic held in the American Legion Stadium in Montebello, California, recently. With the attendance and enthusiasm far exceeding the fondest hopes of its sponsors, the picnic was a marked success in every way. The day's activities, starting at 10 a. m., included varied games and contests, with valuable prizes donated by the company to all winners. Baseball, volley ball, and even track and field events were included on the schedule. A tug-of-war between the office and shop employees climaxed the day-long sports program—won, as you might imagine, by the best sitters. Refreshments at noon and again in the evening, followed by dancing, brought one of the busiest days in the Lane-Wells Company's history to a close.

New Eagle-Picher Distributors Named

The following companies recently were approved by the Eagle-Picher Sales Company as new distributors for Eagle industrial insulating materials: A. Lynn Thomas Company, Inc., Richmond, Virginia; Biggs & Company, Wichita Falls, Texas; Cleveland Fire Brick Company, Cleveland, Ohio; Darragh Company, Little Rock, Arkansas; Donald Sales and Manufacturing Company, Milwaukee, Wisconsin; Edgar H. Pratt Fire Brick Company, Chicago, Illinois; L. A. Foster Engineering Company, St. Louis, Missouri; L. R. Land Construction Company, Oklahoma City, Oklahoma; Lunsford Welding Shop, Inc., Jackson, Mississippi; Michiana Fire Brick Company, South Bend, Indiana; Tri-State Mill Supply Company, Fordyce, Arkansas; Western Windmill Supply Company, Sweetwater, Texas; and Woare Builders Supply Company, Decatur, Illinois.

The Eagle-Picher line of high-temperature insulating materials includes plastics, block and blanket insulation, interior and exterior pipe insulation, fills, and waterproofing cements.

Quick Job of Moving Harvester's General Offices

One of the largest moving jobs in Chicago in ten years took place the week-end of October 8 to 10 in the transfer of the International Harvester Company general offices from 606 South Michigan Avenue, Chicago, to a 23-story building at 180 North Michigan. The work was begun after office hours Friday, October 8, and was completed by 1 p. m. the following Sunday. More than 300 van loads of furniture and equipment for an office personnel of approximately 1000 were moved during Friday and Saturday nights and Sunday forenoon.

Opens Shop and Warehouse at Great Bend

American Iron and Machine Works Company, Oklahoma City, announce the opening of a machine shop and warehouse at Great Bend, Kansas. The Kansas plant is equipped with up-to-date machinery specially selected for the territory served in this greater Kansas field.

The Great Bend plant is under the supervision of R. E. (Bob) Craine, formerly in charge of the Seminole, Oklahoma shop.

Open Baltimore Branch

Steel & Tubes, Inc., subsidiary of Republic Steel Corporation, Cleveland, Ohio, have opened a branch office in Baltimore, Md., according to an announcement by L. W. Harston, vice-president in charge of sales. H. H. Smith is in charge of the new office and will handle the entire line of products, including Electrunite mechanical, boiler, condenser, stainless steel and structural rail carbon steel tubing, Electrunite Steeltubes, and conduit.

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WATER CANS
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GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . .
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Made in 1½, 3, 5, and 10 gallon sizes.
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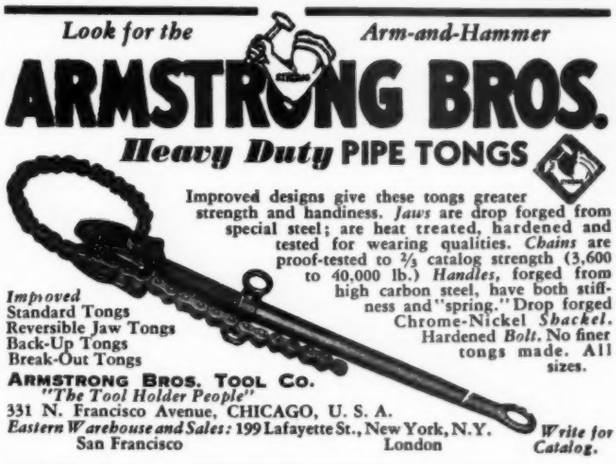
KEEP PURE DRINKING WATER ALWAYS HANDY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Improved designs give these tongs greater strength and handiness. Jaws are drop forged from special steel; are heat treated, hardened and tested for wearing qualities. Chains are proof-tested to ⅔ catalog strength (3,600 to 40,000 lb.) Handles, forged from high carbon steel, have both stiffness and "spring." Drop forged Chrome-Nickel Shackel. Hardened Bolt. No finer tongs made. All sizes.
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Because the MILLER Sand Pump cleans out sand and sediment in your wells, permitting free flowing of the oil.

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To Meet Every Condition

● **BAILER BOTTOM**

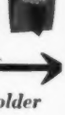
With the Bailer Bottom installed the MILLER is quickly changed to a Bailer giving you a combination of either Bailer or a Sand Pump in one tool.

● **SAND BOTTOM**

Used when tools are run and when well is shot to quickly remove loose material.

● **STAR BOTTOM**

Used for cutting the sand loose.



● **CHISEL BOTTOM**

(In Pump)

With this bottom tightly packed sand can be easily broken in small pieces so it can be picked up in the pump.

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See Page 1186 COMPOSITE CATALOG

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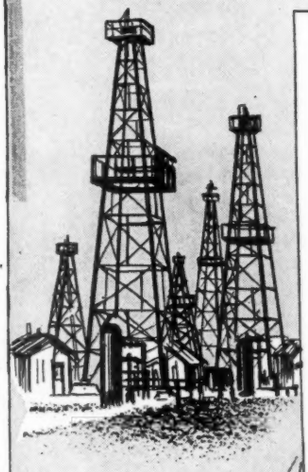
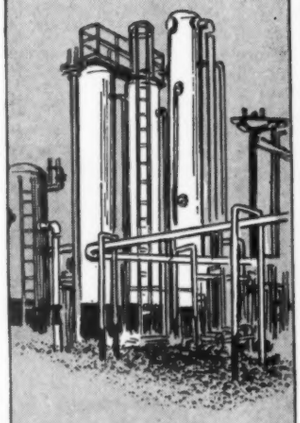




INSTALLMENT No. 5

INTERPOLATION. In mathematics, the insertion of terms in a series according to the law of the series, such as, for example, values in a table, is known as interpolation. The method of interpolation generally used is the direct-ratio method. As an example, assume that the following figures appear in a table:

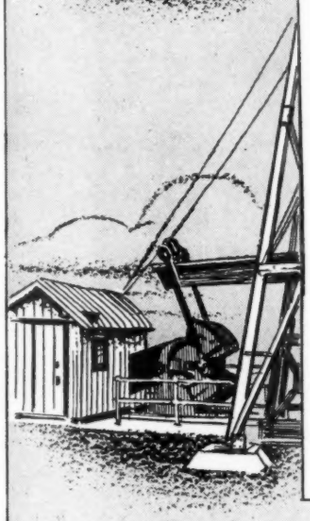
a	b
20	156.8
30	235.2
40	313.6

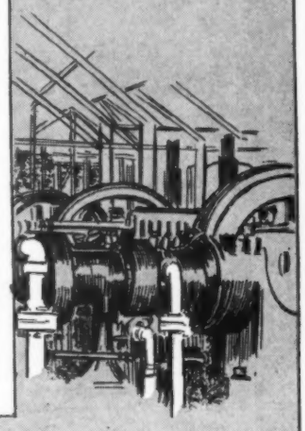
It is desired to find by interpolation from column "b" a value corresponding to the value of 24 in column "a". The value 24 does not appear in column "a", but it lies between the value of 20 and 30. Dividing the interval between these two numbers into ten equal parts the required value, which we shall call x, will be 156.8 plus 4/10 of the difference between 235.2 and 156.8 (these two numbers are the values in column "b" corresponding to the respective values 30 and 20 in column "a")

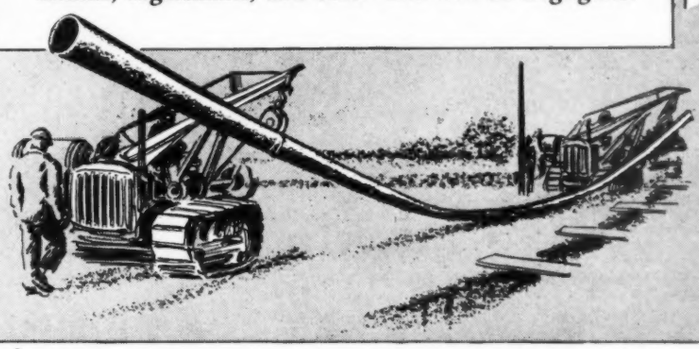
$$\text{or: } x = 156.8 + \frac{4}{10}(235.2 - 156.8)$$

$$x = 188.2$$

This method is accurate only when applied to data based on straight-line or linear functions, i.e., data that when plotted on rectangular co-ordinates fall on a straight line. However, if the intervals between variables are relatively small, the error induced by using the direct-ratio method of interpolation in tables based on exponential, logarithmic, and other data will be negligible.







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Engineering Data Especially Compiled for Office, Field and Plant Use

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*This index is revised monthly as additional tables are published.
(*a*) In footnote, "feet" should read "inches."
(*b*) Headings "Redwood No. 1 seconds" and "Redwood admiralty seconds" should be transposed.

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Johnston, M. O., Oil Field Service Corp.	122	July	P 425.24
Jones & Laughlin Steel Corp.	232	September	P 615.104.40
Kibele Manufacturing Company	226	September	P 532.400.2
Linde Air Products Company, The	132	June	P 649.
Martin-Decker Corp.	128	July	P 422.335
Mason-Neilan Regulator Company	136	June	P 066.
Mason-Neilan Regulator Company	226	August	P 771.214.2
Mid-Continent Pump Supply Company	164	October	P 514.350.20
Mission Manufacturing Company	110	July	P 514.5
Reed Roller Bit Company	258	August	P 432.2
Ridge Tool Company	116	July	P 615.106.40
Skinner, M B., Company	262	August	P 615.108.40
South Chester Tube Company	166	October	P 615.104.20
Staynew Filter Corporation	128	June	P 778.2
Trinity Portland Cement Company	118	July	P 444.
Union Wire Rope Corporation	168	October	P 094.13
Vortox Manufacturing Company	260	August	P 094.843.4
Vortox Manufacturing Company	162	October	P 094.843.6
Westinghouse Electric & Manufacturing Company	160	October	P 753.016.103
Williamsport Wire Rope Company	234	September	P 422.913

EQUIVALENT TOTAL CROSS-SECTIONAL AREA OF DRAINAGE CHANNELS INTO WELL BORE, SQ. FT. PER FT. SAND THICKNESS

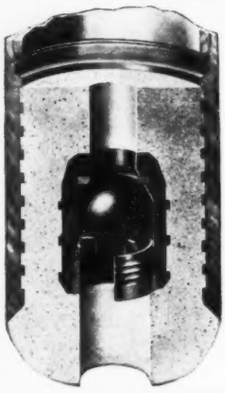
For different diameters of hole and sands of different porosity

Diam. of well, in.	Percent porosity																			
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1½	.027	.031	.035	.039	.043	.047	.051	.055	.059	.063	.067	.071	.075	.079	.082	.086	.090	.094	.098	.102
2	.037	.042	.047	.052	.058	.063	.068	.073	.079	.084	.089	.094	.099	.105	.110	.115	.120	.126	.131	.136
2½	.046	.052	.059	.065	.072	.079	.085	.092	.098	.105	.111	.118	.124	.131	.137	.144	.151	.157	.164	.170
3	.055	.063	.071	.079	.086	.094	.102	.110	.118	.126	.134	.141	.149	.157	.165	.173	.181	.188	.196	.204
3½	.064	.073	.082	.092	.101	.110	.119	.128	.137	.147	.156	.165	.174	.183	.192	.202	.211	.220	.229	.238
4	.073	.084	.094	.105	.115	.126	.136	.147	.157	.168	.178	.188	.199	.209	.220	.230	.241	.251	.262	.272
4½	.082	.094	.106	.118	.130	.141	.153	.165	.177	.188	.200	.212	.224	.236	.247	.259	.271	.283	.295	.306
5	.092	.105	.118	.131	.144	.157	.170	.183	.196	.209	.223	.236	.249	.262	.275	.288	.301	.314	.327	.340
5½	.101	.115	.130	.144	.158	.173	.187	.202	.216	.230	.245	.259	.274	.288	.302	.317	.331	.346	.360	.374
6	.110	.126	.141	.157	.173	.188	.204	.220	.236	.251	.267	.283	.298	.314	.330	.346	.361	.377	.393	.408
6½	.119	.136	.153	.170	.187	.204	.221	.238	.255	.272	.289	.306	.323	.340	.357	.374	.391	.408	.425	.442
7	.128	.147	.165	.183	.202	.220	.238	.257	.275	.293	.312	.330	.348	.367	.385	.403	.421	.440	.458	.476
7½	.137	.157	.177	.196	.216	.236	.255	.275	.295	.314	.334	.353	.373	.393	.412	.432	.452	.471	.491	.511
8	.147	.168	.188	.209	.230	.251	.272	.293	.314	.335	.356	.377	.398	.419	.440	.461	.482	.503	.524	.545
8½	.156	.178	.200	.223	.245	.267	.289	.312	.334	.356	.378	.401	.423	.445	.467	.490	.512	.534	.556	.579
9	.165	.188	.212	.236	.259	.283	.306	.330	.353	.377	.401	.424	.448	.471	.495	.518	.542	.565	.589	.613
9½	.174	.199	.224	.249	.274	.298	.323	.348	.373	.398	.423	.448	.473	.497	.522	.547	.572	.597	.622	.647
10	.183	.209	.236	.262	.288	.314	.340	.367	.393	.419	.445	.471	.497	.524	.550	.576	.602	.628	.655	.681
10½	.192	.220	.247	.275	.302	.330	.357	.385	.412	.440	.467	.495	.522	.550	.577	.605	.632	.660	.687	.715
11	.202	.230	.259	.288	.317	.346	.374	.403	.432	.461	.490	.518	.547	.576	.605	.634	.662	.691	.720	.749
11½	.211	.241	.271	.301	.331	.361	.391	.421	.452	.482	.512	.542	.572	.602	.632	.662	.692	.723	.753	.783
12	.220	.251	.283	.314	.346	.377	.408	.440	.471	.503	.534	.565	.597	.628	.660	.691	.723	.754	.785	.817
12½	.229	.262	.295	.327	.360	.393	.425	.458	.491	.524	.556	.589	.622	.655	.687	.720	.753	.785	.818	.851
13	.238	.272	.306	.340	.374	.408	.442	.476	.511	.545	.579	.613	.647	.681	.715	.749	.783	.817	.851	.885
13½	.247	.283	.318	.353	.389	.424	.459	.495	.530	.565	.601	.636	.672	.707	.742	.778	.813	.848	.884	.919
14	.257	.293	.330	.367	.403	.440	.476	.513	.550	.586	.623	.660	.696	.733	.770	.806	.843	.880	.916	.953
14½	.266	.304	.342	.380	.418	.456	.493	.531	.569	.607	.645	.683	.721	.759	.797	.835	.873	.911	.949	.987
15	.275	.314	.353	.393	.432	.471	.511	.550	.589	.628	.668	.707	.746	.785	.825	.864	.903	.942	.982	1.021
16	.293	.335	.377	.419	.461	.503	.545	.586	.628	.670	.712	.754	.796	.838	.880	.922	.963	1.005	1.047	1.089
17	.312	.356	.401	.445	.490	.534	.579	.623	.668	.712	.757	.801	.846	.890	.935	.979	1.024	1.068	1.113	1.157
18	.330	.377	.424	.471	.518	.565	.613	.660	.707	.754	.801	.848	.895	.942	.990	1.037	1.084	1.131	1.178	1.225
19	.348	.398	.448	.497	.547	.597	.647	.696	.746	.796	.846	.895	.945	.995	1.045	1.094	1.144	1.194	1.244	1.293
20	.367	.419	.471	.524	.576	.628	.681	.733	.785	.838	.890	.942	.995	1.047	1.100	1.152	1.204	1.257	1.309	1.361
21	.385	.440	.495	.550	.605	.660	.715	.770	.825	.880	.935	.990	1.045	1.100	1.155	1.210	1.264	1.319	1.374	1.429
22	.403	.461	.518	.576	.634	.691	.749	.806	.864	.922	.979	1.037	1.094	1.152	1.210	1.267	1.325	1.382	1.440	1.497
23	.421	.482	.542	.602	.662	.723	.783	.843	.903	.963	1.024	1.084	1.144	1.204	1.264	1.325	1.385	1.445	1.505	1.566
24	.440	.503	.565	.628	.691	.754	.817	.880	.942	1.005	1.068	1.131	1.194	1.257	1.319	1.382	1.445	1.508	1.571	1.634
26	.476	.545	.613	.681	.749	.817	.885	.953	1.021	1.089	1.157	1.225	1.293	1.361	1.429	1.497	1.566	1.634	1.702	1.770
28	.513	.586	.660	.733	.806	.880	.953	1.026	1.100	1.173	1.246	1.319	1.393	1.466	1.539	1.613	1.686	1.759	1.833	1.906
30	.550	.628	.707	.785	.864	.942	1.021	1.100	1.178	1.257	1.335	1.414	1.492	1.571	1.649	1.728	1.806	1.885	1.964	2.042

Mr. Engineer:

LET'S CONSIDER FUNDAMENTALS

. . . and See Just WHY Baker Cement Guiding, Floating and Cementing Equipment is so Widely Preferred by Modern Operators



We'll use this sectional view of the Baker Cement Float Shoe as an illustration.

First of all consider *Strength* . . . then note the concrete plug and Bakelite Valve Assembly securely anchored in the seamless steel casing shoe . . . here is ample strength for landing the longest and heaviest string of casing. And yet it is . . .

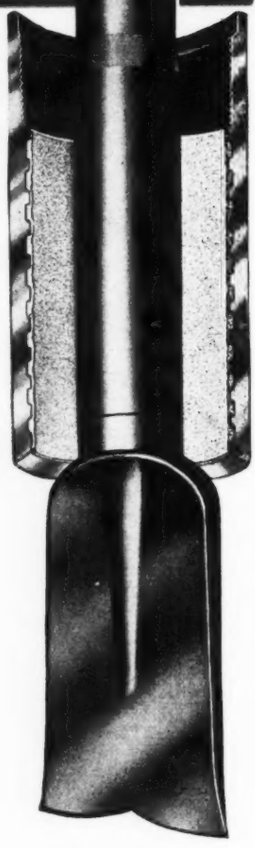
COMPLETELY DRILLABLE

Next see the efficient design of the Valve Assembly . . . with buoyant Bakelite ball which floats in the rotary mud or cement slurry and instantly double-seals against a narrow, tough rubber seal (backed by a Bakelite seat and concrete) at the slightest reversal of pressure.

Here is Valve Efficiency at its best, yet the entire Valve Assembly, being constructed of Bakelite and an insignificant amount of rubber, is

COMPLETELY DRILLABLE

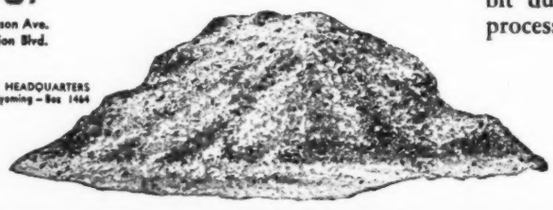
The Complete Story of the STRENGTH, VALVE EFFICIENCY AND DRILLABILITY *of Baker Cement Guiding, Floating, Cementing Equipment is Given on Pages 189 to 206 of the 1937 Composite Catalog . . . and in the large Baker Catalog, gladly sent upon request.*



DRILLABILITY

. . . results from the fact that only special Baker-Formula Concrete and a minimum amount of Bakelite are ever used in the internal construction of Baker Cement Guiding, Floating, Cementing Equipment. Both materials are easily drilled up and the resulting small, harmless particles freely circulated out of the hole. There can be no objectionable fragments left to interfere with immediate coring below the shoe or future drilling operations.

Where *less drillable* materials are used, the operator is confronted with extra bit expense and loss of time in drilling out, or breaking out of such materials from the shoe or collar. Moreover, there is always danger that the recently set cement around the casing will be damaged by the pounding and grinding action of the bit during the drilling out process.



BAKER OIL TOOLS, INC.

Telephone JEfferson 8211 – HUNTINGTON PARK, CALIFORNIA – 2959 E. Slauson Ave.
Telephone WAyside 2108 – HOUSTON PLANT AND OFFICE – 6023 Navigation Blvd.

MID-CONTINENT OFFICE AND WAREHOUSE:
Telephone 2-8083 – Tulsa, Oklahoma – 312 East Fourth Street

WEST TEXAS BRANCH OFFICE
Odessa, Texas – Telephone 217

EXPORT SALES OFFICE
Rm. 1914 – 19 Rector St., New York City
Tel. Digby 4-5515

ROCKY MOUNTAIN HEADQUARTERS
Tel. 2230-Casper, Wyoming – Box 1464

BAKER CEMENT GUIDING FLOATING & CEMENTING EQUIPMENT

VISCOSITY-GRAVITY CONSTANT OF OIL

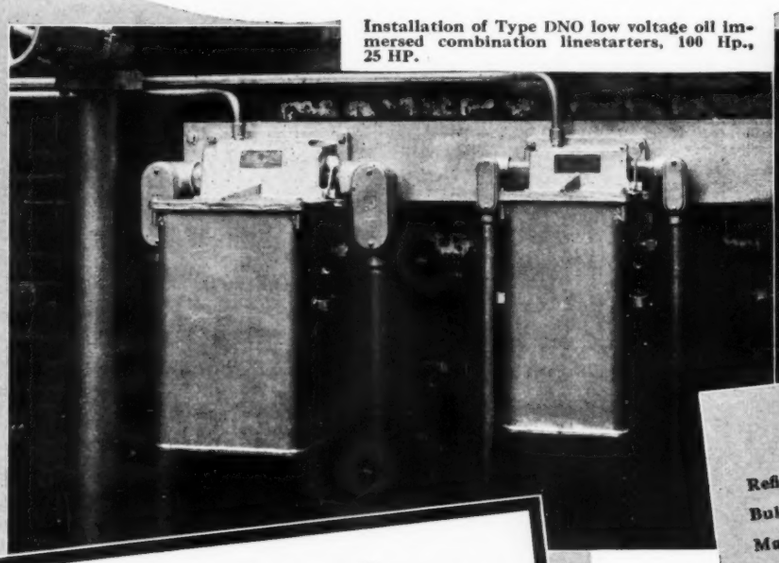
Viscosity of oil at 100 deg. fahr., Saybolt Universal seconds	Gravity of oil, °A. P. I.									
	16	20	24	28	32	36	40	44	48	52
100	.934	.903	.873	.846	.820	.794	.770	.748	.726	.705
120	.932	.901	.871	.843	.816	.790	.766	.743	.720	.699
140	.930	.899	.868	.840	.813	.787	.762	.739	.716	
160	.929	.897	.866	.838	.810	.784	.759	.735	.713	
180	.927	.895	.865	.836	.808	.782	.756	.732	.710	
200	.926	.894	.863	.834	.806	.780	.754	.730	.707	
220	.925	.893	.862	.832	.804	.778	.752	.728	.705	
240	.924	.892	.860	.831	.802	.776	.750	.726	.702	
260	.924	.891	.859	.829	.801	.774	.748	.724	.700	
280	.923	.890	.858	.828	.800	.773	.747	.722	.699	
300	.922	.889	.857	.827	.798	.771	.745	.721		
320	.922	.888	.856	.826	.797	.770	.744	.719		
340	.921	.887	.855	.825	.796	.769	.743	.718		
360	.921	.887	.855	.824	.795	.768	.741	.716		
380	.920	.886	.854	.823	.794	.767	.740	.715		
400	.920	.885	.853	.822	.793	.766	.739	.714		
450	.918	.884	.851	.820	.791	.763	.736	.711		
500	.917	.883	.850	.819	.789	.761	.734	.709		
550	.916	.881	.849	.817	.787	.759	.732	.706		
600	.915	.880	.847	.816	.786	.757	.730	.704		
650	.915	.880	.846	.815	.784	.756	.729	.702		
700	.914	.879	.845	.813	.783	.754	.727	.701		
750	.913	.878	.844	.812	.782	.753	.725	.669		
800	.912	.877	.843	.811	.780	.751	.724			
850	.912	.876	.842	.810	.779	.750	.723			
900	.911	.875	.841	.809	.778	.749	.721			
950	.911	.875	.840	.808	.777	.748	.720			
1000	.910	.874	.840	.807	.776	.747	.719			
1100	.909	.873	.838	.805	.774	.745	.717			
1200	.908	.872	.837	.804	.773	.743	.714			
1300	.907	.871	.836	.803	.771	.741	.713			
1400	.906	.870	.835	.801	.770	.740	.711			
1500	.906	.869	.834	.800	.768	.738	.709			
1600	.905	.868	.833	.799	.767	.737	.708			
1700	.904	.867	.832	.798	.766	.735	.706			
1800	.904	.866	.831	.797	.765	.734	.705			
1900	.903	.865	.830	.796	.763	.733	.704			
2000	.902	.865	.829	.795	.762	.732	.702			
2100	.902	.864	.828	.794	.761	.730	.701			
2200	.901	.863	.827	.793	.760	.729	.700			
2300	.901	.863	.827	.792	.759	.728	.699			
2400	.900	.862	.826	.791	.759	.727				
2500	.900	.862	.825	.791	.758	.727				
2600	.899	.861	.825	.790	.757	.726				
2700	.899	.860	.824	.789	.756	.725				
2800	.898	.860	.823	.788	.755	.724				
2900	.898	.859	.823	.788	.755	.723				
3000	.898	.859	.822	.787	.754	.722				

Values calculated from formula of Hill and Coats, "The Viscosity-Gravity Constant of Petroleum Lubricating Oils," *Ind. Eng. Chem.* **20**, 641 (1928).

Something to Shout About!

"DE-ION" NOW FOR THE FIRST TIME GIVES *Fuseless* CIRCUIT PROTECTION IN OIL IMMERSED MOTOR STARTERS . . .

Installation of Type DNO low voltage oil immersed combination linestarters, 100 Hp., 25 HP.



Super Safe for

- Refineries
- Bulk Stations
- Marine Terminals
- Gas Compressor Stations
- Natural Gasoline Plants
- Pipe Line Pumping

These Advantages

EXPLOSION-PROOF—Meets Underwriters specifications for Class 1 Group D hazardous locations.

CORROSION RESISTING—By virtue of suitable oil immersion of all live parts.

"DE-ION" EQUIPPED CONTACTOR—Assures supersafety, reliability and exceptional contact life.

"DE-ION" FUSELESS PROTECTION—Fuseless short circuit protection provided by oil immersed NOFUZE "De-ion" BREAKER.

OVERLOAD PROTECTION—By oil immersed thermal induction type relays.

WEATHER PROOF—Can be mounted out doors. Construction is drip-proof, splash-proof, dust-tight.

RELIABLE—The "De-ion" Arc Quencher divides, confines and extinguishes the arc—prevents flashover, gives high overload capacity and trouble-free operation.

The exclusive "De-ion" principle of arc quenching after years of success on Westinghouse safety switches and NOFUZE circuit Breakers was incorporated in the full line of Westinghouse "De-ion" motor starters and control equipment. In applying the famous "De-ion" principle of arc quenching to the new oil immersed motor starters, Westinghouse engineers have now made another remarkable advance.

This time-tested method of arc interruption banishes once and for all the losses resulting from fuse outages and sets a new high standard of motor starter performance. The starter contacts are also "De-ion" equipped so that you get the protection of "De-ion" arc quenching each time the starter operates. In addition "De-ion" is your insurance of exceptional contact life, super safety and complete dependability. J 20416

Send for this book. It gives the complete story of what "De-ion" means to immersed motor starters. Ask for B. 2118, Dept. 7N, Westinghouse, East Pittsburgh, Pa.

WESTINGHOUSE ELECTRIC

Westinghouse
Oil Immersed Motor Starters

PISTON DISPLACEMENT (CU. IN.) AND RATED HORSEPOWER FOR 6-CYLINDER MOTORS; FOR 12-CYLINDER MOTORS MULTIPLY GIVEN DISPLACEMENT BY 2

Cylinder bore, in.	Stroke, in.																															S.A.E. rating, HP.
	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4	4⅛	4¼	4⅜	4½	4⅝	4¾	4⅞	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞	6	6¼	6½	6¾	7	7¼	7½	7¾	8	
2⅛	88	92	96	99	103	107	110	114	118	122	125	129	133	136	140	144	147	151	155	158	162	166	169	173	177	184	191	199	206	214	221	228	235	15.0
2⅜	97	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	171	175	179	183	187	191	195	203	211	219	227	235	244	251	260	16.54
2¾	107	111	116	120	125	129	134	138	143	147	152	156	160	165	169	174	178	183	187	192	196	201	205	209	214	223	232	241	249	258	267	276	285	18.14
2⅞	117	122	127	131	136	141	146	151	156	161	166	170	175	180	185	190	195	200	205	209	214	219	224	229	234	243	253	263	273	283	293	302	312	19.82
3	127	132	138	143	148	154	159	164	170	175	180	186	191	196	201	207	212	217	223	228	233	239	244	249	254	265	276	286	297	308	318	329	340	21.6
3⅛	138	144	150	156	161	167	173	178	184	190	196	201	207	213	219	224	230	236	242	247	253	258	265	270	276	288	299	311	322	334	345	356	368	23.45
3¼	149	155	162	168	174	180	186	193	199	205	212	218	224	230	236	243	249	255	261	268	274	280	286	292	299	311	324	336	348	360	373	385	398	25.35
3⅜	161	168	174	181	188	194	201	208	215	221	228	235	242	248	255	262	268	275	282	289	295	302	309	315	322	336	349	362	376	389	403	416	430	27.3
3½	173	180	188	195	202	209	216	224	231	238	245	253	260	267	274	281	289	296	303	310	317	325	332	339	346	361	375	390	404	418	433	447	461	29.4
3⅝	186	194	201	209	216	224	232	240	247	255	263	271	278	286	294	302	309	317	325	333	340	348	356	364	371	387	402	418	433	449	465	480	495	31.5
3¾	199	207	215	224	232	240	248	256	265	273	282	290	298	307	315	323	331	340	348	356	365	373	381	389	398	414	431	447	464	480	496	513	530	33.7
3⅞	212	221	230	239	248	257	266	274	283	292	301	310	318	327	336	345	354	363	371	380	389	398	407	416	425	442	460	478	495	514	531	549	567	36.0
4	226	236	245	254	264	274	283	292	302	311	320	329	339	349	358	368	377	386	396	405	415	424	434	443	452	471	490	509	528	546	565	585	604	38.4
4⅛	241	251	261	271	281	291	301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	501	521	541	561	581	601	621	641	40.9
4¼	255	266	276	287	298	308	319	330	341	351	362	372	383	394	404	415	426	436	447	458	468	479	490	500	511	532	553	575	596	617	638	659	680	43.4
4⅜	271	282	293	305	316	327	338	350	361	372	383	395	406	417	428	440	451	462	474	485	496	507	519	530	541	564	586	600	631	653	677	700	722	45.9
4½	286	298	310	322	334	346	358	370	382	394	406	418	429	441	453	465	477	489	501	513	525	537	549	561	573	596	620	644	668	692	716	740	764	48.6
4⅝	302	315	328	340	353	365	378	391	403	416	428	441	454	466	479	491	504	517	529	542	554	567	580	592	605	630	655	680	706	730	756	781	806	51.3
4¾	319	332	346	359	372	386	399	412	425	439	452	465	479	492	505	518	532	545	558	572	585	598	611	625	638	665	691	718	744	770	798	825	851	54.2
4⅞	336	350	364	378	392	406	420	434	448	462	476	490	504	518	532	546	560	574	588	602	616	630	644	658	672	700	728	756	784	812	840	868	896	57.0
5	353	368	383	398	412	427	442	457	471	486	501	515	530	545	560	574	589	604	619	633	648	663	677	692	707	736	765	795	825	854	884	913	942	60.0
5⅛	371	387	402	418	433	449	464	480	495	511	526	542	557	573	588	603	619	634	650	665	681	696	712	727	743	774	805	836	866	897	928	959	990	63.1
5¼	390	406	422	439	455	471	487	504	520	536	552	568	585	601	617	633	649	666	682	698	714	731	747	763	779	812	844	877	909	941	975	1008	1040	66.2
5⅜	409	426	443	459	476	494	510	527	545	562	579	596	613	630	647	664	681	698	715	732	749	766	783	800	817	851	885	919	953	987	1021	1056	1090	69.4
5½	428	445	464	481	499	516	535	553	570	588	606	624	641	659	677	695	713	731	748	766	784	802	820	838	855	891	927	962	998	1033	1069	1105	1141	72.7
5⅝	448	466	485	504	523	540	559	578	597	615	634	653	671	690	709	728	746	765	784	802	821	839	858	876	893	932	970	1007	1044	1082	1119	1156	1193	75.9
5¾	468	487	506	526	546	565	585	604	624	643	662	682	702	721	740	760	780	799	819	838	857	877	896	916	935	974	1013	1052	1092	1130	1170	1209	1248	79.4
5⅞	488	509	529	550	570	590	610	631	651	671	692	712	732	753	773	794	814	835	855	875	896	916	936	957	977	1018	1059	1099	1140	1180	1211	1261	1302	82.8
6	509	530	552	573	595	615	636	658	679	700	722	743	764	785	806	828	849	870	891	912	934	955	976	998	1019	1060	1101	1142	1184	1226	1270	1314	1358	86.4
6¼	553	575	598	621	645	667	690	713	736	760	782	805	828	852	875	897	920	941	967	990	1014	1038	1060	1084	1106	1152	1199	1245	1292	1339	1384	1429	1474	93.8
6½	598	623	647	672	697	722	747	772	796	821	846	871	896	921	946	971	996	1020	1044	1068	1093	1118	1143	1169	1195	1246	1296	1346	1395	1445	1495	1544	1594	101.4
6¾	644	670	696	724	750	777	804	831	858	885	911	938	965	992	1020	1047	1075	1101	1128	1155	1182	1209	1236	1263	1289	1342	1398	1452	1505	1558	1612	1666	1720	109.3
7	693	722	751	780	809	837	866	895	924	953	981	1011	1041	1070	1099	1128	1157	1286	1214	1243	1272	1301	1330	1359	1388	1446	1504	1562	1620	1678	1736	1794	1848	117.7
7¼	744	774	805	836	867	898	929	960	991	1022	1053	1084	1116	1147	1178	1209	1240	1271	1302	1333	1364	1395	1426	1457	1488	1550	1614	1676	1737	1799	1860	1921	1982	126.2
7½	796	829	862	895	928	961	995	1028	1061	1094	1127	1160	1193	1227	1260	1293	1326	1359	1392	1425	1458	1491	1524	1557	1592	1658	1725	1791	1858	1925	1991	2058	2124	135.0
7¾	850	886	921	957	992	1027	1062	1098	1133	1169	1204	1240	1275	1311	1346	1382	1417	1453	1488	1524	1559	1595	1630	1665	1700	1771	1841	1912	1983	2054	2125	2196	2267	144.2
Factor "A"	.500	.521	.542	.563	.583	.604	.625	.646	.667	.688	.708	.729	.750	.771	.792	.813	.833	.854	.875	.896	.917	.938	.958	.979	1.000	1.042	1.083	1.125	1.167	1.208	1.250	1.292	1.333	

S. A. E. horsepower rating is based on 1000 feet per minute piston speed. To find equivalent horsepower at 1000 revolutions per minute, multiply S. A. E. rating for given bore, by factor "A" for given stroke.

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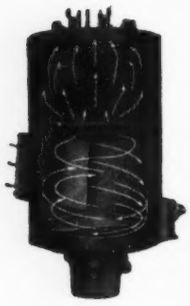
VORTOX AIR CLEANERS give *Continuous* CLEANING EFFICIENCY



When you install a Vortox Triple-Action Air Cleaner you get peak cleaning efficiency right from the start. The patented Triple-Action Cleaning Principle* assures that!

But, what's more important, you will continue to get peak cleaning efficiency right through the long life of the Vortox Cleaner. Today . . . next week . . . five years from now —it makes no difference. You will find your Vortox Cleaner giving the same high cleaning efficiency it gave when new.

Why? Because in the patented Vortox Cleaning Principle there are no cloth filters to become choked with dust, and the incoming air does not pass through increasingly dust-laden felts or moss. ALL the dust removed by the Vortox Cleaner settles in oil and is trapped below a baffle plate which positively prevents it from again contacting the incoming air. There are no moving parts, nothing to wear out, nothing to replace. The only maintenance required is a cleaning of the dirt sump and a refilling with light oil at regular intervals.

And remember this—if a Vortox Cleaner of the proper size is correctly installed and is serviced regularly, it *will never strangle your engine!* Not only do you get continuously clean air, but also a *constant* flow of air, because the crimped steel wire filter is thoroughly drenched with circulating oil which keeps it thoroughly clean. In every Vortox Air Cleaner you get the *extra dividend* of efficient air intake silencing at no extra cost!

No wonder there are more Vortox Air Cleaners used by the oil and gas industry than any other type!

*THE VORTOX TRIPLE-ACTION CLEANING PRINCIPLE.

1. Heavy dust particles are thrown out by centrifugal force of whirling air column.
2. Fine dust particles are thoroughly removed by an oil scrubbing action.
3. Air is given a final filtering through an oil-washed wire filter element that sends it into the engine clean and completely dry.

VORTOX MANUFACTURING CO.
CLAREMONT, CALIFORNIA

VORTOX OIL TYPE SELF-WASHING **AIR CLEANER**

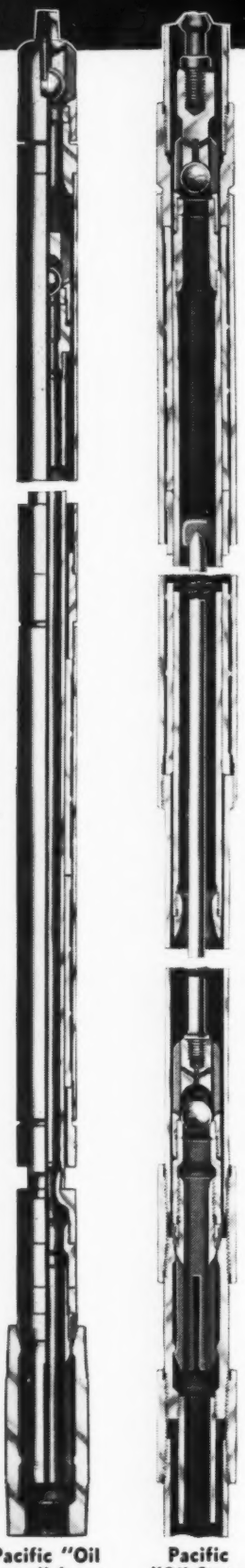
MAXIMUM SAFE PUMPING DEPTH, FT., FOR WOODEN WALKING BEAMS PUMPING 20 DEG. A.P.I. FLUID

Plunger diam., in.	Rod diam., in.	Size and kind* of beam: 14 x 18 in.				14 x 24 in.				16 x 24 in.				14 x 30 in.				16 x 30 in.			
		CS-DF	SSES-SP	S-DF	DH-SP	CS-DF	SSES-SP	S-DF	DH-SP	CS-DF	SSES-SP	S-DF	DH-SP	CS-DF	SSES-SP	S-DF	DH-SP	CS-DF	SSES-SP	S-DF	DH-SP
1	¾	2,910	3,310	3,430	3,690	5,270	5,960	6,190	6,660	6,020	6,810	7,080	7,610	8,320	9,400	9,770	10,490	9,510	10,750	11,160	11,990
1 1/16	¾	2,840	3,230	3,350	3,610	5,150	5,830	6,060	6,510	5,890	6,660	6,920	7,440	8,130	9,200	9,550	10,260	9,300	10,510	10,910	11,720
1¼	¾	2,640	3,000	3,110	3,350	4,780	5,410	5,620	6,040	5,460	6,180	6,420	6,900	7,550	8,530	8,860	9,520	8,630	9,750	10,130	10,880
1½	¾	2,370	2,690	2,790	3,010	4,290	4,860	5,050	5,420	4,900	5,550	5,770	6,200	6,780	7,660	7,960	8,550	7,750	8,760	9,090	9,770
	⅞	1,820	2,060	2,140	2,300	3,290	3,720	3,870	4,150	3,760	4,250	4,420	4,750	5,190	5,870	6,100	6,550	5,930	6,710	6,970	7,480
	1	1,530	1,740	1,800	1,940	2,770	3,130	3,250	3,500	3,160	3,580	3,720	4,000	4,370	4,940	5,130	5,510	5,000	5,650	5,860	6,300
1¾	¾	2,120	2,410	2,500	2,700	3,850	4,350	4,520	4,860	4,400	4,980	5,170	5,560	6,080	6,870	7,130	7,660	6,940	7,850	8,150	8,750
	⅞	1,660	1,890	1,960	2,110	3,010	3,410	3,540	3,800	3,440	3,890	4,040	4,350	4,750	5,370	5,580	5,990	5,430	6,140	6,380	6,850
	1	1,420	1,610	1,670	1,800	2,570	2,910	3,020	3,240	2,930	3,320	3,450	3,710	4,060	4,590	4,760	5,110	4,640	5,240	5,440	5,840
1.7810	¾	2,090	2,370	2,460	2,650	3,780	4,280	4,450	4,780	4,320	4,890	5,080	5,460	5,980	6,760	7,020	7,540	6,830	7,720	8,020	8,610
	⅞	1,650	1,870	1,940	2,090	2,980	3,370	3,500	3,770	3,410	3,860	4,010	4,300	4,710	5,320	5,530	5,940	5,380	6,080	6,320	6,780
	1	1,410	1,600	1,660	1,780	2,550	2,880	2,990	3,220	2,910	3,290	3,420	3,680	4,020	4,550	4,720	5,070	4,600	5,200	5,400	5,800
2	¾	1,890	2,150	2,230	2,400	3,420	3,870	4,020	4,320	3,910	4,420	4,600	4,940	5,400	6,110	6,340	6,810	6,180	6,980	7,250	7,790
	⅞	1,510	1,720	1,790	1,920	2,740	3,100	3,220	3,470	3,130	3,550	3,690	3,960	4,330	4,900	5,090	5,460	4,950	5,600	5,810	6,240
	1	1,310	1,490	1,550	1,670	2,380	2,690	2,790	3,000	2,720	3,070	3,190	3,430	3,750	4,240	4,410	4,730	4,290	4,850	5,040	5,410
2¼	¾	1,680	1,910	1,980	2,130	3,040	3,440	3,570	3,840	3,470	3,930	4,080	4,390	4,800	5,430	5,640	6,050	5,490	6,200	6,440	6,920
	⅞	1,380	1,560	1,620	1,750	2,490	2,820	2,930	3,150	2,850	3,220	3,350	3,600	3,940	4,450	4,620	4,960	4,500	5,090	5,280	5,670
	1	1,210	1,370	1,420	1,530	2,190	2,470	2,570	2,760	2,500	2,830	2,940	3,160	3,450	3,900	4,050	4,350	3,950	4,460	4,630	4,980
2½	¾	1,490	1,700	1,760	1,890	2,700	3,060	3,180	3,420	3,090	3,500	3,630	3,900	4,270	4,830	5,010	5,380	4,880	5,520	5,730	6,150
	⅞	1,250	1,420	1,480	1,590	2,270	2,570	2,670	2,860	2,590	2,930	3,050	3,270	3,580	4,050	4,200	4,510	4,090	4,630	4,800	5,160
	1	1,110	1,260	1,310	1,410	2,010	2,270	2,360	2,540	2,290	2,600	2,700	2,900	3,170	3,580	3,720	4,000	3,620	4,090	4,250	4,570
2¾	¾	1,330	1,520	1,570	1,690	2,410	2,730	2,840	3,050	2,760	3,120	3,240	3,490	3,810	4,310	4,480	4,810	4,360	4,930	5,120	5,490
	⅞	1,140	1,290	1,340	1,440	2,060	2,330	2,420	2,600	2,350	2,660	2,760	2,970	3,250	3,670	3,810	4,090	3,710	4,190	4,360	4,680
	1	1,020	1,160	1,200	1,290	1,840	2,090	2,170	2,330	2,110	2,380	2,480	2,660	2,910	3,290	3,420	3,670	3,330	3,760	3,910	4,190
3	¾	1,190	1,350	1,400	1,510	2,160	2,440	2,530	2,720	2,460	2,790	2,900	3,110	3,410	3,850	4,000	4,290	3,890	4,400	4,570	4,910
	⅞	1,030	1,170	1,210	1,310	1,870	2,110	2,190	2,360	2,130	2,410	2,510	2,690	2,950	3,330	3,460	3,710	3,370	3,810	3,950	4,250
	1	930	1,060	1,100	1,180	1,690	1,910	1,990	2,130	1,930	2,180	2,270	2,440	2,670	3,010	3,130	3,360	3,050	3,450	3,580	3,840
3¼	¾	1,070	1,210	1,260	1,350	1,930	2,190	2,270	2,440	2,210	2,500	2,600	2,790	3,050	3,450	3,580	3,850	3,490	3,940	4,090	4,400
	⅞	940	1,070	1,110	1,190	1,700	1,920	2,000	2,150	1,940	2,200	2,280	2,450	2,680	3,030	3,150	3,380	3,070	3,460	3,600	3,860
	1	850	970	1,010	1,080	1,550	1,750	1,820	1,960	1,770	2,000	2,080	2,230	2,440	2,760	2,870	3,080	2,790	3,160	3,280	3,520
3¾	¾	870	980	1,020	1,100	1,570	1,780	1,840	1,980	1,790	2,030	2,110	2,270	2,480	2,800	2,910	3,120	2,830	3,200	3,320	3,570
	⅞	780	890	920	990	1,410	1,600	1,660	1,780	1,610	1,830	1,900	2,040	2,230	2,520	2,620	2,810	2,550	2,880	2,990	3,210
	1	720	820	850	910	1,310	1,480	1,540	1,650	1,490	1,690	1,750	1,890	2,060	2,330	2,420	2,600	2,360	2,660	2,770	2,970
4¼	¾	710	810	840	900	1,290	1,460	1,520	1,630	1,480	1,670	1,740	1,860	2,040	2,310	2,390	2,570	2,330	2,630	2,740	2,940
	⅞	650	740	770	830	1,180	1,340	1,390	1,490	1,350	1,530	1,590	1,710	1,870	2,110	2,190	2,350	2,130	2,410	2,500	2,690
	1	610	700	720	780	1,110	1,250	1,300	1,400	1,270	1,430	1,490	1,600	1,750	1,980	2,050	2,210	2,000	2,260	2,350	2,520
4¾	¾	590	680	700	750	1,080	1,220	1,270	1,360	1,230	1,390	1,450	1,550	1,700	1,920	2,000	2,140	1,940	2,200	2,280	2,450
	⅞	550	630	650	700	1,000	1,130	1,180	1,260	1,140	1,290	1,340	1,440	1,580	1,790	1,850	1,990	1,810	2,040	2,120	2,280
	1	520	590	620	660	950	1,070	1,110	1,200	1,080	1,220	1,270	1,370	1,490	1,690	1,750	1,880	1,710	1,930	2,000	2,150

*C.S.-D.F. Common structural grade Douglas Fir. S.S.E.S.-S.P. Structural Square Edge and Sound grade Southern Pine. S.-D.F. Structural grade Douglas Fir. D.H.-S.P. Dense Heart grade Southern Pine.

PACIFIC DEEP WELL PLUNGER PUMPS

For Every Field and Condition



Pacific "Oil States" Insert Liner Pump

Pacific "Oil States" Tubing Type Liner Pump

STREAMLINED TO PRODUCE MORE FLUID

With Less HP—Less Emulsion—Prevent Ball Spin

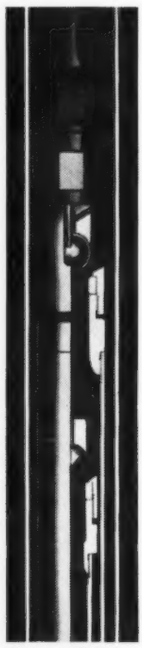
Designed and built for less friction and greater speed, Pacific Pumps lift oil without turbulence; quicker, easier, more economically.

MOLOY METAL LINERS REDUCE FRICTION

Moloy Liners require less power; add life to deep well oil pumps. Withstand the most severe conditions of sand, high pressure, abrasion, corrosion and temperature.

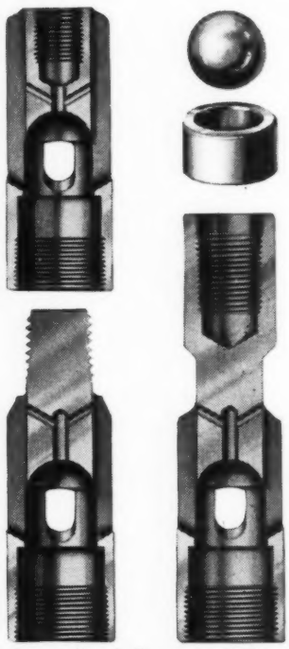
MOLOY METAL PERMITS CLOSER TOLERANCE

Anti-friction qualities and extreme toughness due to special alloying, give Moloy Metal a sorbitic texture of supreme wearing resistance and high tensile strength—permit "metal-to-metal" contact without sticking or galling.



Streamlining Feature Increases Pumping Efficiency

Pacific Moloy Liners Reduce the Power Required and Materially Lengthen Life of Deep Well Oil Pumps.



Streamlined Cages and Fittings Produce More Fluid with Less HP — Less Emulsion—Prevents Ball Spin.

Write for "Oil States" Streamline Bulletin

MID-CONTINENT PUMP SUPPLY COMPANY

TULSA, OKLAHOMA

Subsidiary, Pacific Pump Works

Distributors: Kansas; Pampa and Borger, Texas, Bovaird Supply Co. Texas and Louisiana, Mid-Continent Supply Company

PRESSURE DROP, LB. PER SQ. IN. PER MILE OF 4-IN. PIPE LINE (OIL OF 20 DEG. A.P.I.)

Quantity of 20° A.P.I. oil, bbl. per hr.	Viscosity of oil, Saybolt Universal seconds										
	140	160	180	200	220	240	260	280	300	320	340
100	17.78	18.49	19.12	19.73	20.22	20.70	21.13	21.87	23.47	25.05	26.64
105	19.33	20.11	20.81	21.47	22.01	22.53	23.00	23.56	24.63	26.30	27.97
110	20.96	21.81	22.57	23.28	23.88	24.44	24.96	25.57	26.04	27.57	29.31
115	22.63	23.54	24.37	25.13	25.79	26.39	26.97	27.63	28.13	28.81	30.65
120	24.35	25.34	26.23	27.03	27.75	28.39	29.05	29.74	30.27	30.75	31.97
125	26.11	27.18	28.13	28.99	29.76	30.45	31.16	31.91	32.47	32.99	33.60
130	27.94	29.07	30.08	31.02	31.85	32.60	33.35	34.14	34.74	35.30	35.99
135	29.86	31.03	32.13	33.14	34.03	34.84	35.63	36.46	37.11	37.71	38.45
140	31.82	33.05	34.21	35.27	36.23	37.10	37.92	38.82	39.49	40.17	40.96
145	33.81	35.11	36.32	37.46	38.50	39.43	40.28	41.21	41.94	42.66	43.52
150	35.85	37.23	38.51	39.72	40.80	41.80	42.71	43.68	44.46	45.23	46.15
155	37.95	39.40	40.73	42.00	43.18	44.25	45.22	46.20	47.03	47.88	48.83
160	40.11	41.66	43.07	44.37	45.63	46.76	47.80	48.81	49.69	50.61	51.61
165	42.29	43.93	45.44	46.78	48.12	49.32	50.43	51.47	52.40	53.38	54.42
170	44.53	46.27	47.83	49.26	50.64	51.92	53.10	54.20	55.19	56.19	57.26
175	46.84	48.65	50.31	51.78	53.21	54.56	55.81	56.98	58.03	59.09	60.18
180	49.19	51.06	52.82	54.37	55.85	57.28	58.60	59.83	60.95	62.02	63.14
185	51.61	53.59	55.40	57.04	58.56	60.07	61.46	62.77	63.95	65.09	66.22
190	54.02	56.11	58.02	59.71	61.31	62.87	64.33	65.71	66.95	68.15	69.31
195	56.53	58.68	60.69	62.47	64.15	65.74	67.29	68.69	70.00	71.27	72.48
200	59.06	61.32	63.39	65.26	67.03	68.66	70.28	71.76	73.14	74.46	75.70
205	61.72	64.04	66.22	68.18	69.99	71.65	73.36	74.91	76.36	77.75	79.05
210	64.37	66.76	69.04	71.10	72.95	74.69	76.42	78.05	79.57	81.04	82.39
215	67.07	69.57	71.91	74.07	76.00	77.82	79.59	81.29	82.89	84.36	85.79
220	69.80	72.42	74.80	77.07	79.09	81.00	82.78	84.57	86.24	87.79	89.28
225	72.57	75.31	77.80	80.10	82.22	84.21	86.08	87.89	89.63	91.25	92.81
230	75.40	78.26	80.87	83.28	85.43	87.51	89.46	91.29	93.11	94.80	96.43
235	78.30	81.29	83.94	86.39	88.70	90.80	92.84	94.68	96.58	98.35	100.05
240	81.23	84.35	87.05	89.60	92.01	94.21	96.26	98.18	100.16	102.00	103.78
245	84.20	87.38	90.26	92.85	95.36	97.65	99.71	101.71	103.78	105.70	107.54
250	87.20	90.51	93.43	96.20	98.74	101.12	103.28	105.35	107.43	109.43	111.35
255	90.28	93.72	96.76	99.56	102.20	104.69	106.93	109.09	111.17	113.25	115.25
260	93.35	96.93	100.09	102.92	105.66	108.24	110.57	112.90	114.98	117.06	119.14
265	96.45	100.16	103.45	106.38	109.24	111.83	114.25	116.67	118.83	120.99	123.06
270	99.57	103.52	106.93	109.89	112.85	115.54	118.05	120.47	122.71	124.96	127.02
275	102.82	106.82	110.35	113.43	116.50	119.29	121.89	124.31	126.64	128.87	131.10
280	106.15	110.29	113.96	117.15	120.23	123.13	125.83	128.34	130.75	132.97	135.29
285	109.46	113.76	117.46	120.76	123.95	126.95	129.75	132.35	134.75	137.15	139.55
290	112.80	117.25	121.08	124.50	127.71	130.81	133.71	136.40	138.88	141.37	143.75
295	116.19	120.79	124.75	128.29	131.61	134.71	137.71	140.50	143.17	145.64	147.99
300	119.59	124.24	128.45	132.11	135.43	138.64	141.74	144.62	147.39	149.93	152.37
305	123.19	127.89	132.24	136.02	139.45	142.77	145.98	148.95	151.70	154.33	156.85
310	126.78	131.51	136.01	139.91	143.46	146.89	150.08	153.16	155.99	158.71	161.32
315	130.28	135.17	139.81	143.84	147.50	151.04	154.22	157.39	160.44	163.25	165.94
320	133.81	138.85	143.77	147.93	151.58	155.23	158.51	161.79	164.81	167.71	170.48
325	137.50	142.70	147.63	151.92	155.82	159.46	162.84	166.22	169.34	172.20	175.06
330	141.27	146.63	151.59	156.01	160.03	163.78	167.27	170.62	173.97	176.92	179.73
335	145.01	150.54	155.65	160.07	164.35	168.08	171.67	175.12	178.44	181.61	184.51
340	148.76	154.45	159.57	164.26	168.53	172.37	176.06	179.62	183.03	186.30	189.29
345	152.61	158.47	163.74	168.57	172.96	176.77	180.58	184.24	187.76	191.12	194.20
350	156.50	162.53	167.81	172.94	177.31	181.38	185.30	188.92	192.69	196.01	199.17
355	160.37	166.58	172.01	177.12	181.78	185.96	189.84	193.72	197.44	200.85	204.27
360	164.27	170.65	176.23	181.50	186.28	190.59	194.58	198.40	202.23	205.74	209.25
365	168.20	174.76	180.50	185.91	190.83	195.25	199.35	203.29	207.06	210.83	214.27
370	172.16	178.90	184.79	190.35	195.41	199.95	204.16	208.04	211.91	215.79	219.33
375	176.19	183.11	189.17	194.88	200.07	204.75	209.07	213.06	217.04	221.02	224.48
380	180.38	187.31	193.53	199.39	204.73	209.52	213.97	218.05	222.14	226.05	229.78
385	184.60	191.53	198.09	203.93	209.40	214.33	218.89	223.08	227.10	231.11	235.12
390	188.85	195.96	202.51	208.50	214.11	218.98	223.85	227.97	232.27	236.39	240.32
395	193.14	200.43	207.15	213.10	218.86	223.85	228.84	233.07	237.48	241.71	245.74
400	197.51	204.99	211.69	217.79	223.70	228.82	233.94	238.27	242.60	247.13	251.07

WHETHER you run miles of oil or gas line—or only a few lengths of standard pipe—you are assured of a perfect fitting joint when you use Chester Pipe.

At every stage of manufacture, and in the field as well, Chester Pipe is safeguarded by careful workmanship and by years of experience in building pipe to fit every need. Use Chester in your next installation—and you'll be set for economical operation for a long time to come.

SOUTH CHESTER TUBE CO. Chester, Pa.

District Sales Managers

F. H. Gibson, 1331 Gulf Building, Pittsburgh, Pa.

J. P. Cooney, 715-716 A. G. Bartlett Building, Los Angeles, Calif.

J. P. Steele, Petroleum Building, Fort Worth, Texas.

District Offices

South Chester Tube Co., 1708 Hudson Terminal Building, 30 Church Street, New York, N. Y.

J. D. Swartz, Beacon Building, Tulsa, Oklahoma.

E. L. Moseley, 2218 Mills Street, Houston, Texas.

District Warehouses

Houston, Texas; Thenard, Calif.; San Francisco, Calif.

Distributors

Western Supply Co., Tulsa, Okla., and Branches.

International Supply Co., Tulsa, Okla., and Branches.

Dunigan Tool and Supply Co., Breckenridge, Texas and Branches.

Bridgeport Machine Co., Wichita, Kansas and Branches.

Louisiana Supply Co., Sulphur and Brimstone, La.

Oil Field Equipment Co., San Antonio, Texas.

Industrial Supply Co., Inc., Wichita Falls, Texas and Branches.

Okmulgee Supply Corp., Okmulgee, Okla., and Branches.

Stephen H. McCabe, 508 4th Street, San Francisco, Calif.

Viking Automatic Sprinkler Co., 2715 East 12th Street, Los Angeles, Calif.

Herley Supply Co., 3006 Cherry Ave., Long Beach, Calif.

Tubular Sales Co., 811 West Seventh Street Bldg., Los Angeles, Calif.

Barde Steel Co., Seattle, Wash., and Portland, Ore.

Star Drilling Machine Co., 550 Clinton Street, Portland, Ore., and Akron, Ohio.

The Atha Supply Co., Zanesville, Ohio, and Mt. Pleasant, Mich.

United Pipe & Supply Corporation, Charleston, W. Va., and Branches.

Prichard Supply Co., Mannington, W. Va., and Branches.

CHESTER

STEEL CASING AND LINE PIPE

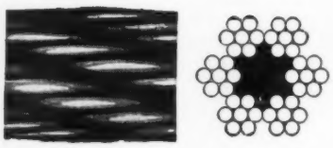
CHARACTERISTICS OF OIL INDUSTRY WIRE ROPE

Kind of line	Size, in.	Strand	Lay	Core	Strength, tons[1] Grade: Cast steel API "N"	Mild plow steel API "L"	Plow steel API "J"	Improved plow steel	Wt. per 100 ft., lb.	Sheave diameter, in.: Recommended	Minimum
Sand or bailing (¼"–⅝"), pumping (½"–1"), standard drilling (¾"–1¼")	¼	6x7 "Hard laid"	Right for sand lines, right or left for drilling and pumping lines	Hemp	2.0	2.2	2.3	2.7	9.4	18	11
	9/32				2.5	2.7	2.9	3.4	12	20	12
	5/16				3.1	3.4	3.6	4.2	15	23	13
	⅜				4.3	4.7	5.1	5.9	21	27	16
	7/16				5.8	6.3	6.9	7.9	29	32	19
	½				7.5	8.2	9.0	10.3	38	36	21
	9/16				9.4	10.3	11.3	13.0	48	41	24
	⅝				11.5	12.6	13.8	16.0	59	45	27
	¾				16.5	18.1	19.8	22.8	84	54	32
	⅞				22.4	24.6	26.8	30.8	115	63	37
	1				29.0	31.9	34.8	40.0	150	72	42
	1⅛				36.4	40.0	43.6	50.0	190	81	47
	1¼				44.5	48.7	53.0	61.0	234	90	53
Swabbing and standard drilling and casing (⅝"–1¼"), rotary drilling and casing (¾"–1⅛"), and bailing (9/16"–¾"), tubing and rod (⅜"–⅞")	⅜	6x19 "Soft laid"	Right or left	Hemp	4.5	5.0	5.5	6.3	23	17	11
	7/16				6.0	6.6	7.3	8.4	31	20	13
	½				7.7	8.5	9.4	10.8	40	23	15
	9/16				9.6	10.6	11.7	13.5	51	26	17
	⅝				11.8	13.1	14.4	16.6	63	28	19
	¾				16.8	18.7	20.6	23.7	90	34	22
	⅞				22.8	25.4	28.0	32.2	123	40	26
	1				29.5	33.0	36.5	42.0	160	45	30
	1⅛				37.0	41.5	46.0	53.0	203	51	34
	1¼				46.0	51.0	56.5	65.0	250	56	38
	¾			Wire rope	18.0	20.1	22.1	25.5	99	34	22
	⅞				24.5	27.3	30.1	34.6	135	40	26
	1				31.7	35.5	39.2	45.2	176	45	30
	1⅛				39.8	44.6	49.4	57.0	223	51	34
	1¼				49.4	54.8	60.7	69.9	275	56	38
Tubing and rod	⅜	6x31 or 6x37	Right	Hemp	4.4	4.9	5.3	6.1	22	10	7
	½				7.7	8.4	9.2	10.6	39	13½	9
	⅝				11.6	12.8	14.0	16.1	61	17	11
	¾				16.4	18.1	19.8	22.8	87	20	13½
	⅜			Wire rope	4.7	5.3	5.7	6.5	24	10	7
	½				8.3	9.0	9.9	11.4	43	13½	9
	⅝				12.5	13.7	15.0	17.3	67	17	11
	¾				17.6	19.4	21.3	24.5	96	20	13½
Tubing and rod (non-spinning)	⅝	18x7	Right (inner rope left)	Hemp	10.9	12.1	13.3	15.3	68	32	21
	¾				15.6	17.3	19.0	21.9	97	38	26
	⅞				21.1	23.5	25.9	29.8	132	45	30
	1				27.3	30.5	33.8	38.8	173	51	34
	1⅛				34.2	38.4	42.5	49.0	219	57	38
Torpedo	⅛	5x5	Right	Fibre				1050*	2.2		
	9/64							1400*	2.8		
	3/16							2800*	5.1		
								*lb.			

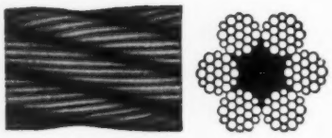
[1]A safety factor of 5 or larger should be used. These breaking strength specifications apply to ordinary and preformed wire rope but not to flattened strand lines.

UNION WIRE LINES OFFER

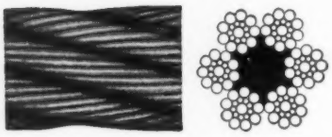
7 Advantages



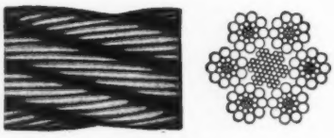
6x7



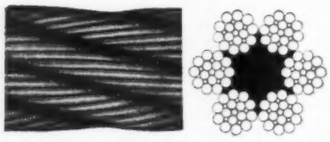
6x19 Warrington



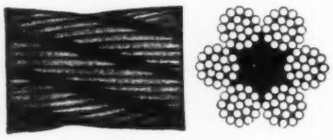
6x19 Seale



6x19 Flexible Seale with I.W.R.C.



6x16 Filler Wire



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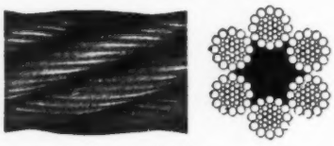
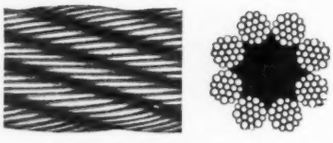
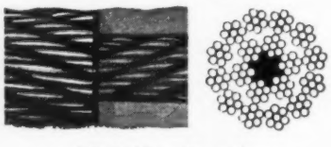


6x31



8x19 Warrington



18x7 Non-Rotating

1 DESIGNED BY OIL MEN. The Oil Fields have their own special wire rope requirements. UNION Wire Lines are manufactured in the world's most intensive oil producing area, and are designed especially for the extra-severe conditions of oil field service by engineers who know the oil fields and are constantly studying oil field conditions at first hand.

2 ENGINEERS OF NATIONAL REPUTATION. Every step in the fabrication of UNION Wire Lines from specification steel rods is under the control, within our own plant, of wire rope engineers of many years' experience with leading wire rope makers and of national reputation. Thus we control the making of the wire, including patenting, cleaning, baking, die-making, and the wire drawing itself. Every coil of wire is tested by a department controlled absolutely separately from either the Wire Mill which makes it or the Rope Shop which fabricates the rope. Fabrication of wire into strands and of strands and cores into rope, takes place in our own plant. Equipment is the finest obtainable.

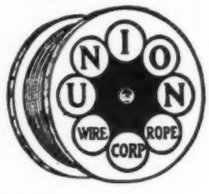
3 SPECIAL CORES. UNION Cores are especially made from highest grade hemp and are treated at the cordage factory for internal preservation and lubrication. They are then run through a bath of especially developed hot preservative while being laid into the finished rope, insuring the best internal lubrication possible.

4 COMPLETE LINE, INCLUDING "PRE-FORMED" ("UNION-FORMED"). UNION offers wire lines especially suited to every oil field service. In addition to the regular line, UNION manufactures "UNION-FORMED" (Pre-Formed) Wire Rope for those who desire rope which will not unravel and from which internal stresses have been removed.

5 UNIFORM QUALITY. The foregoing policies develop lines which are UNIFORM in quality. Field records prove that UNION Lines are *extra-durable* in service, thus are economical in the long run.

6 FIELD RESEARCH. The UNION Engineering Staff is constantly conducting field and laboratory research in the endeavor to further perfect UNION Lines. The recommendations of our Engineering Staff are available to every user of UNION Lines, at all times.

7 A. P. I. SPECIFICATIONS. All UNION Oil Country Lines are manufactured in accordance with A.P.I. Specifications.



UNION WIRE ROPE CORPORATION

21st and Manchester Avenue, Kansas City, Missouri
Oil Country Sales Office: 601 Beacon Building, Tulsa, Oklahoma
Branch: Portland, Oregon. Warehouses: Chicago, Illinois; Monahans, Texas.

JARECKI MFG. CO.

In Mexico:
E. O. CHAPA
P. O. Box 604
Tampico, Tamps
Mexico. Stocks
At Tampico

Distributors: Midcontinent, New Mexico and Eastern Oil Fields

MARION MACHINE FOUNDRY & SUPPLY CO.
Rocky Mountain Fields, Except New Mexico

Export Agents:
(except Mexico)
LUCEY EXPORT CORP.
Woolworth Bldg.,
New York; Broad St.
House, London

UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"

CONCRETE CORNER FOUNDATIONS FOR DRILLING DERRICKS

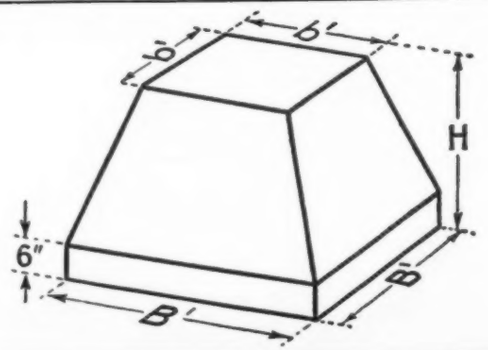
Maximum load on any corner, lb.	Length of side of plate square, b′, ft. in.	Bearing power of soil, lb. per sq. ft.																					
		1,500 Alluvium, etc.			3,000 Soft clay, etc.			6,000 Sand, etc.			10,000 Thick dry clay, etc.			15,000 Rock, etc.			30,000 Dense limestone						
		B′ ft. in.	H ft. in.	V cu. yd.	B′ ft. in.	H ft. in.	V cu. yd.	B′ ft. in.	H ft. in.	V cu. yd.	B′ ft. in.	H ft. in.	V cu. yd.	B′ ft. in.	H ft. in.	V cu. yd.	B′ ft. in.	H ft. in.	V cu. yd.				
10,000	1 2[a]	5 9	1 5	.7[b]	4 10	2 0	.7[b]	4 1	2 4	.7[b]	3 9	2 7	.7[b]	3 6	2 7	.7[b]			.7[b]				
20,000	1 2	5 9	1 5	.7	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
30,000	1 2	5 9	1 5	.7	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
40,000	1 2	5 9	1 5	.7	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
50,000	1 2	5 9	1 5	.7	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
60,000	1 2	6 4	1 9	1.1	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
70,000	1 2	6 10	2 0	1.4	4 10	2 0	.7	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
80,000	1 2	7 4	2 3	1.8	5 2	2 3	.9	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
90,000	1 3	7 9	2 5	2.2	5 6	2 4	1.1	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
100,000	1 4	8 2	2 7	2.5	5 9	2 6	1.3	4 1	2 4	.7	3 9	2 7	.7	3 6	2 7	.7			.7				
110,000	1 4½	8 7	2 8	2.8	6 1	2 7	1.5	4 4	2 6	.8	3 9	2 7	.7	3 6	2 7	.7			.7				
120,000	1 5½	8 11	2 10	3.3	6 4	2 9	1.7	4 6	2 7	.9	3 9	2 7	.7	3 6	2 7	.7			.7				
130,000	1 6	9 4	2 11	3.8	6 7	2 10	1.9	4 8	2 8	1.0	3 9	2 7	.7	3 6	2 7	.7			.7				
140,000	1 6½	9 8	3 1	4.3	6 10	2 11	2.2	4 10	2 10	1.2	3 9	2 7	.7	3 6	2 7	.7			.7				
150,000	1 7½	10 0	3 2	4.7	7 1	3 1	2.4	5 0	2 11	1.3	3 11	2 8	.8	3 6	2 7	.7			.7				
160,000	1 8	10 4	3 3	5.1	7 4	3 2	2.7	5 2	3 0	1.4	4 0	2 9	.9	3 6	2 7	.7			.7				
170,000	1 8½	10 8	3 4	5.5	7 6	3 3	2.9	5 4	3 1	1.5	4 2	2 10	.9	3 6	2 7	.7			.7				
180,000	1 9	10 11	3 5	6.0	7 9	3 4	3.2	5 6	3 2	1.7	4 3	2 11	1.0	3 6	2 7	.7			.7				
190,000	1 10	11 3	3 7	6.7	8 0	3 5	3.4	5 8	3 3	1.8	4 4	3 0	1.1	3 7	2 8	.7			.7				
200,000	1 10½	11 7	3 8	7.2	8 2	3 6	3.7	5 9	3 4	2.0	4 6	3 1	1.2	3 8	2 9	.8			.7				
210,000	1 11	11 10	3 9	7.8	8 4	3 7	4.0	5 11	3 5	2.1	4 7	3 2	1.3	3 9	2 10	.9			.7				
220,000	1 11½	12 1	3 10	8.3	8 7	3 8	4.3	6 1	3 6	2.3	4 8	3 3	1.4	3 10	2 11	.9			.7				
230,000	2 0	12 5	3 11	8.9	8 9	3 9	4.6	6 2	3 7	2.4	4 10	3 4	1.5	3 11	2 11	1.0			.7				
240,000	2 ½	12 8	4 0	9.4	8 11	3 10	4.9	6 4	3 8	2.6	4 11	3 5	1.6	4 0	3 0	1.1			.7				
250,000	2 1	12 11	4 1	10.0	9 2	3 11	5.2	6 5	3 9	2.8	5 0	3 5	1.7	4 1	3 1	1.1			.7				
260,000	2 1½	13 2	4 2	10.6	9 4	4 0	5.5	6 7	3 10	2.9	5 1	3 6	1.8	4 2	3 2	1.2			.7				
270,000	2 2	13 5	4 3	11.2	9 6	4 1	5.8	6 9	3 10	3.0	5 2	3 7	1.9	4 3	3 2	1.2			.7				
280,000	2 2½	13 8	4 3	11.6	9 8	4 2	6.2	6 10	3 11	3.2	5 4	3 8	2.0	4 4	3 3	1.3			.7				
290,000	2 3	13 11	4 4	12.3	9 10	4 3	6.5	6 11	4 0	3.4	5 5	3 9	2.1	4 5	3 4	1.4			.7				
300,000	2 3½	14 2	4 5	13.0	10 0	4 4	6.9	7 1	4 1	3.6	5 6	3 9	2.2	4 6	3 4	1.5			.7				

Derrick footings of sufficient size to meet the requirements for preventing overturn by wind[b] will have ample bearing surface and height if set on rock of this bearing power.

[a] Recommended minimum base plate size

[b] A.P.I. Recommended Minimum to Prevent Overturn by Wind

A.P.I. Size No.	Cu. yd. required	Cu. yd. recommended
8	0.610	¾
9	1.202	1½
10	1.859	2
11-A	2.505	2¾
11	1.653	1¾
12	2.089	2¼
16	3.882	4
18	5.732	6



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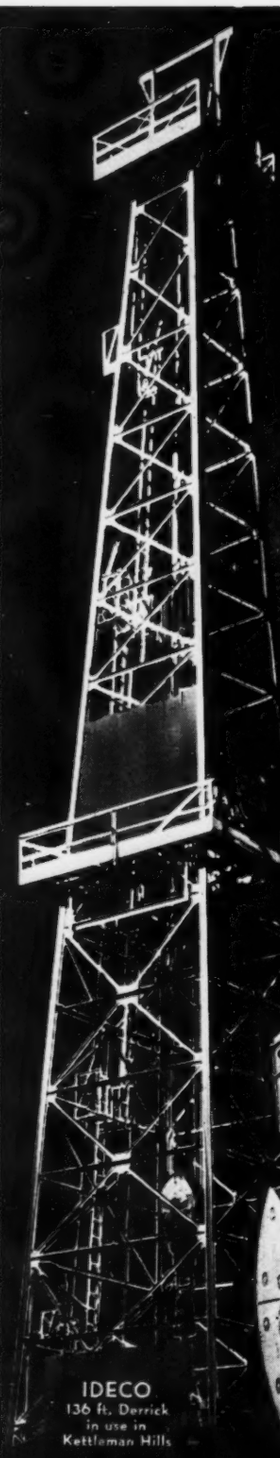

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